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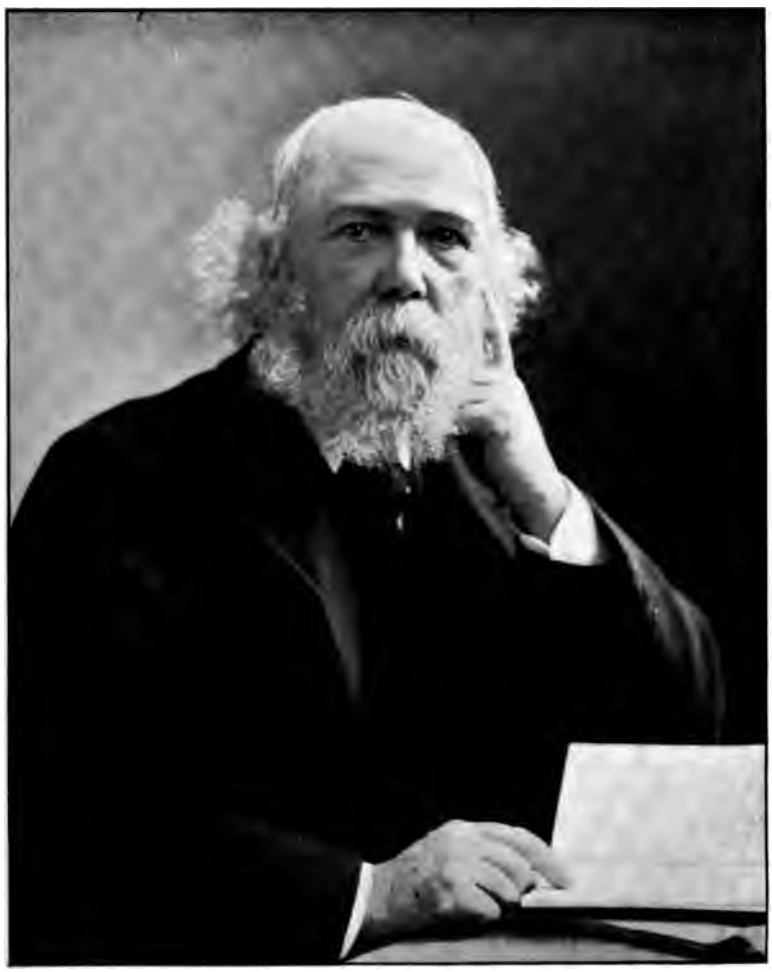

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Each Ordinary Member shall be more than twenty-three years of age, have been regularly educated as a mining, metallurgical, or mechanical engineer, or in some other branch of engineering, according to the usual routine of pupilage, and have had subsequent employment for at least two years in some responsible situation as an engineer; or if he has not undergone the usual routine of pupilage, he must have been employed or have practised as an engineer for at least five years.

* Deceased.

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FORD, CHARLES FREDERICK VERNON, Marehay Main Colliery, Ripley, Derby.
FORD, JAMES, Coalville, near Leicester.
FORD, MARK, Washington Colliery, Washington Station, Co. Durham.
FORD, STANLEY HORACE, P.O. Box 2056, Johannesburg, Transvaal.
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FORREST, JOHN CHARLES, Holly Bank Colliery, Essington, Wolverhampton.
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FORSTER, JOHN HENRY BACON, Cramlington Colliery, Northumberland.
FORSTER, JOSEPH WILLIAM, New Kleinfontein Company, P.O., Benoni, Transvaal.
FORSTER, RICHARD PERCIVAL, Mount Pleasant, Spennymoor, R.S.O., Co. Durham.
FORSTER, THOMAS EMERSON, 3, Eldon Square, Newcastle-upon-Tyne.
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FORSYTH, JAMES, Park Terrace, Falkirk, N.B.
FORSYTH, WILLIAM, Greenhill Colliery, Cleland, S.O., Lanarkshire.
FOSTER, GEORGE, Lyme Villa, Rotherham.
FOSTER, GEORGE, Castlestead, Boston Spa, Yorkshire.
FOULSTONE, W., Coach and Horses Hotel, Barnsley.
FOWLER, GEORGE, Basford Hall, Nottingham.
FOWLER, GEORGE CARRINGTON, The Cliff, Cinder Hill, Nottingham.
FOWLER, GEORGE HERBERT, Hall End, Tamworth, Warwickshire.
FOWLER, W. C., Beeston, Notts.
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FREW, WILLIAM, Parkfoot Colliery, Shotts, R.S.O., Lanarkshire.
FROST, WILLIAM, Sneyd Colliery, Burslem, Stoke-upon-Trent.
FRYAR, JOHN WILLIAM, Eastwood Collieries, near Nottingham.
FRYAR, MARK, Denby Colliery, Derby.
FRYAR, WILLIAM, Brisbane, Queensland, Australia.
FRYER, GEORGE KELLETT, Alston House, Crigglestone, near Wakefield.
FUTERS, THOMAS CAMPBELL, Broomhill, Acklington, Northumberland.

GAINSFORD, THOMAS R., Woodthorpe Hall, Sheffield.
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GARDNER, HUGH, Minas Schwager, Coronel, Chile.
GARDNER, JOSEPH MIDDLETON, Park View, Little Houghton, near Barnsley.
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GIBB, WALTER, Tannochside Colliery, Uddingston, N.B.
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GRAINGER, HERBERT, Zululand Collieries, Somkeli, Zululand, South Africa.
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GRAVE, PERCY, Concepcion del Oro, Estado de Zacatecas, Mexico.
GRAVES, HENRY GEORGE.
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GRAY, FRANCIS WILLIAM, c/o Dominion Coal Company, Glace Bay, Sydney, Cape Breton, Nova Scotia.
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GREENER, THOMAS YOUNG, West Lodge, Crook, Darlington.
GREENHALGH, ROBERT, Atherton, Manchester.
GREENSMITH, JOHNSON, Newstead Colliery, Nottingham.
GREENSMITH, JOSEPH, Monckton Main Colliery, Barnsley.
GREENSMITH, THOMAS, c/o J. and G. Wells, Eckington Collieries, Sheffield.
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HADFIELD, ROBERT ABBOTT, Hecla Steel Foundry, Sheffield.
HAGGIE, DAVID HENRY, Wearmouth Patent Rope Works, Sunderland.
HAGGIE, PETER SINCLAIR, Gateshead-upon-Tyne.
HAGGIE, ROBERT HOOD, 4, Thornhill Crescent, Sunderland.
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HALL, JOHN, Swadlincote and Cadley Hill Collieries, Burton-upon-Trent.
HALL, JOHN CHARLES, Shotton Colliery, Castle Eden, R.S.O., Co. Durham.
HALL, JOSEPH JOHN, Ashington Colliery, Morpeth, Northumberland.
HALL, LEVI J., Morland House, Birch Vale, near Stockport.
HALL, MATTHEW, 32, Louis Street, Leeds.
HALL, MATTHIAS STOKOE, Springwell Villa, Bishop Auckland.
HALL, TOM, Ryhope Colliery, *via* Sunderland.
HALL, WILLIAM FAIRBAIRN, Haswell Colliery, Haswell, *via* Sunderland.
HALLAS, GEORGE HENRY, Huyton, near Liverpool.
HALLAS, W., Grimethorpe, near Barnsley.
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HAMILTON, WILLIAM, Boghead and Mosside Collieries, Bathgate, N.B.
HANCOCK, HENRY LIPSON, Moonta Mines, South Australia.
HANCOCK, HENRY RICHARD, Nalyappa, Moonta, South Australia.
HANN, ROBERT, Jun., Grange Hill, near Bishop Auckland.
HANNAH, DAVID, Brynderwen, Ferndale, South Wales.
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HARGREAVES, THOMAS, Newton Vale, Woodland Grove, Chapeltown, Leeds.
HARGREAVES, WALTER, Newmarket and Haigh Moor Collieries, Rothwell, Leeds.
HARGREAVES, W. A., Micklefield Colliery, Micklefield, near Leeds.
HARKER, WILLIAM, Cannon Street House, London, E.C.
HARLE, PETER, Pagebank Colliery, Co. Durham.
HARLE, RICHARD, Browney Colliery, Durham.
HARLE ROBERT ALFRED, Alma Cottage, Campbell's Hill, West Maitland, New South Wales.
HARPER, J. POVEY, All Saints' Chambers, Derby.
HARRIS, DAVID, Elands Laagte Colliery, Limited, Elands Laagte, Natal, South Africa.
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HARRISON, GEORGE BRABBON, H.M. Inspector of Mines, Swinton, near Manchester.
HARRISON, GEORGE DAY, Waterworks, Hanley, Staffordshire.
HARRISON, WILLIAM B., Brownhills Collieries, near Walsall.
HART, ROBERT.
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HAY, JOHN, Canklow, Rotherham.
HAY, ROBERT, Stanton Colliery, Burton-upon-Trent.
HAY, THOMAS YOUNG, Whitwick Colliery, Coalville, Leicester.

HAY, WILLIAM, Shirebrook Colliery, near Mansfield.
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HEATH, ROBERT, Biddulph Valley Iron Works, Stoke-upon-Trent.
HEATHCOTE, C. H., Woodlands, Mansfield.
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HEDLEY, W. E., Woodlesford, Leeds.
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HENDERSON, CHARLES, Cowpen Colliery Office, Blyth, Northumberland.
HENDERSON, JAMES, Ayr Colliery, Annbank Station, N.B.
HENDERSON, JOHN, Dunnikeir Colliery, Kirkcaldy, N.B.
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HENZELL, CHARLES GEORGE, Municipal Buildings, Leeds.
HEPPEL, EDWARD MIDDLETON, Camerton Collieries, near Bath.
HEPPELL, W. J., Cwmaman Colliery, Aberdare, South Wales.
HEPPLEWHITE, RICHARD HUTTON FRITH, Tibshelf, near Alfreton.
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HESLOP, MICHAEL, Rough Lea Colliery, Willington, Co. Durham.
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HESLOP, WILLIAM TAYLOR, St. George's Colliery, Hatting Spruit, Natal, South Africa.
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HILL, THOMAS, Houldsworth Colliery, Patna, R.S.O., Ayrshire.

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HOLLIDAY, CYRUS, East Ardsley Collieries, near Wakefield.
HOLLIDAY, MARTIN FORSTER, Langley Grove, Durham.
HOLLIDAY, NORMAN STANLEY, Langley Grove, Durham.
HOLLIDAY, T., Canklow, Rotherham.
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HOOPER, JAMES, Derwent, St. Agnes, Scorrier, R.S.O., Cornwall.
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HUGHES, JOHN, Dudley, Worcestershire.
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HUMBLE, JOHN, West Pelton House, Beamish, R.S.O., Co. Durham.
HUMBLE, JOSEPH, Markham Collieries, Duckmanton, Chesterfield.
HUMBLE, WILLIAM, Lawson Street, Hamilton, Newcastle, New South Wales.
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WELFORD, THOMAS, Wallarah Colliery, Catherine Hill Bay, New South Wales.
WHITEHEAD, THOMAS, Brindle Lodge, Preston, Lancashire.
WOOD, ARTHUR NICHOLAS LINDSAY, The Hermitage, Chester-le-Street.
WRAITH, GEORGE HENRY, Moor House, Spennymoor, R.S.O., Co. Durham.
WRIGHTSON, WILFRID INGRAM, Neasham Hall, Darlington.

YOUNG, MRS. H. E., Atlin, British Columbia.

Associates.

Assoc.Inst.M.E.

Associates shall be persons acting as under-viewers, under-managers, or in other subordinate positions in mines or metallurgical works, or employed in analogous positions in other branches of engineering.

ADAMS, CHARLES, Whitfield Collieries, Norton-in-the-Moors, Stoke-upon-Trent.
ALLPORT, EDWARD ASTON, Lound House, Haxey, *via* Doncaster.
ARCHER, MATTHEW WILLIAM, High Priestfield, Lintz Green, Co. Durham.
ARMOUR, WILLIAM, Deanfield, Irvine, N.B.
ARMSTRONG, HENRY, South View House, Greenhill, Murton Colliery, near Sunderland.
ARMSTRONG, WILLIAM, Jun., Wingate, R.S.O., Co. Durham.
ARMSTRONG, WILLIAM P., Bewicke Main, Birtley, R.S.O., Co. Durham.
ATKINSON, BERTRAM, 2, Devonshire Terrace, Newcastle-upon-Tyne.

BAMBOROUGH, JACOB, Mason View, Seaton Burn, Dudley, R.S.O., Northumberland.
BARKER, THOMAS, Cotes Park, Alfreton.
BATES, JOHNSON, 5, Grange Villa, Chester-le-Street, Co. Durham.
BATTEY, THOMAS, Station Road, Shiremoor, Northumberland.
BAYLDON, HAROLD CRESSWELL, c/o Bechuanaland Exploration Company, Limited, P.O. Box 4505, Johannesburg, Transvaal.
BELL, WALTER, Clay Cross Collieries, Chesterfield.
BELL, WILLIAM, Plashetts, Northumberland.
BENSON, HERBERT SYDNEY, Shield Row Hall, Stanley, R.S.O., Co. Durham.
BERKLEY, ROBERT, c/o W. T. Berkley, 106, John Street, Co-operative Villas, Beamish, R.S.O., Co. Durham.
BEWICK, GEORGE, Johnsons Terrace, West Auckland, Co. Durham.
BEXTON, RICHARD, 20, Station Road, Holmwood, Heath, near Chesterfield.
BLAIR, ROBERT, 6, Hamilton Terrace, Whitehaven, Cumberland.
BOOTH, FREDERICK LANCELOT, Ashington Colliery, Morpeth.
BOWES, THOMAS, Pontop House, Annfield Plain, R.S.O., Co. Durham.
BRITTAIN, SAMUEL, Mitchell Main, Wombwell, near Barnsley.
BROMLEY, OLIVER J., Midland Coal, Coke and Iron Company, Limited, Apedale, Newcastle, Staffordshire.
BROWN, J. STANLEY, Sydney, Cape Breton, Canada.
BURT, THOMAS, Engine Square, Washington Colliery, Co. Durham.

CARROLL, JOHN, Spring Bank House, Newfield, Willington, Co. Durham.
CHARLTON, WILLIAM JOHN, Jun., 17, First Row, Ashington, Morpeth, Northumberland.
CHEESMAN, MATTHEW FORSTER, Throckley Colliery, Newburn, R.S.O., Northumberland.
CHIPCHASE, JOHN, Trimdon Colliery, near Ferryhill, Durham.
CLARE, HENRY, Birchenwood Colliery Company, Limited, Kidsgrove, Stoke-upon-Trent.
CLARK, NATHANIEL J., 1, Hawthorn Terrace, Pelton Fell, Chester-le-Street, Co. Durham.
CLARKE, SAMUEL, Shirebrook Colliery, Mansfield.
CLIVE, ROBERT, Bentley Colliery, near Doncaster.
CLOUGH, EDWARD STOKOE, Bomarsund House, Bomarsund, Bedlington, R.S.O., Northumberland.
CLOUGH, JOHN, 1, Melton Terrace, Seaton Delaval, R.S.O., Northumberland.
COADE, SAMUEL, Steel Green, Millom, Cumberland.
COATES, WILLIAM, 53, Cornhill, Norton-in-the-Moors, Stoke-upon-Trent.
COCKBURN, EDMUND, 27, Bolckow Street, North Skelton, Skelton-in-Cleveland, Yorkshire.
COCKBURN, EVAN, Waldridge Colliery, Chester-le-Street, Co. Durham.
COCKBURN, JOHN, Fatfield Road, Washington, Co. Durham.
COLLIER, W. R., 1, Chestnut Grove, Gedling, Nottingham.
COLLIN, WILLIAM C. A., Clifton Colliery, Nottingham.
COLLIS, G. E., Chapel Road, Grassmoor, Chesterfield.
COOK, GEORGE, Binchester Hall, Bishop Auckland.

COWELL, EDWARD, Boldon Colliery, Brockley Whins, R.S.O., Co. Durham.
COWLEY, SILAS SCRAFTON, 14, Model Street, New Seaham, *via* Sunderland.
COWX, H. F., Olive Cottage, Sycamore Terrace, Haswell, *via* Sunderland.
COXON, SAMUEL GEORGE, 13, Station View, Waterhouses, Co. Durham.
COXON, WILLIAM BILTON, South View, Crook, Co. Durham.
CRAWFORD, ROBERT, 79, Clerk Street, Loanhead, R.S.O., Mid Lothian.
CROFTON, CHARLES ARTHUR, Dovecote Moor Coal Company, Limited, Clifton, Morpeth, Northumberland.
CROWLE, PERCY, 51, Mainsgate Road, Millom, Cumberland.
CROWTHER, HERBERT, Earl Fitzwilliam's Collieries, Elsecar, Barnsley.
CUMMINGS, JOHN, Moor House, Littletown Colliery, near Durham.
CUNNINGHAM, DAVID, Emily Bank, Arniston, Gorebridge, Mid Lothian.

DAKERS, JOHN, 32, South Street, Brandon Colliery, Durham.
DANKS, FRANCIS, Salsburgh, Holytown, N.B.
DANSKIN, THOMAS, Springwell Colliery, Gateshead-upon-Tyne.
DAVIS, ALFRED, Lethbridge Colliery, Alta, Canada.
DAVIS, JAMES E., South Medomsley Colliery. Dipton, R.S.O., Co. Durham.
DAVISON, FRANCIS, 37, Hedley Hill Terrace, Waterhouses, Co. Durham.
DICKINSON, ARCHIBALD, 283, Colne Road, Burnley, Lancashire.
DIXON, GEORGE, Palana Colliery, Bikaner, Rajputana, India.
DOBSON, THOMAS, The Silverdale Collieries, Newcastle, Staffordshire.
DUNNACHIE, WILLIAM JAMES NIMMO, Newlands, Mount Vernon, Glasgow.
DUNNETT, SAMUEL, West View House, Coomassie Road, Waterloo, Blyth, Northumberland.

EADIE, JOHN ALLAN, Jun., Blaydon Burn Colliery, Blaydon-upon-Tyne.
EASTWOOD, ROBINSON, Lyndhurst, Crigglestone, near Wakefield.
ELLIOTT, CHRISTOPHER, 11, Front Street, East Stanley, Co. Durham.
ELLIOTT, J. W., Kirkby Colliery, Kirkby-in-Ashfield, Nottingham.
ELVES, EDWARD, Sherburn Colliery, near Durham.
EMMERSON, GEORGE, Oakenshaw Colliery, Willington, S.O., Co. Durham.
ENGLISH, THOMAS WEDDLE, Whittington, Corbridge-upon-Tyne.
ESKDALE, JOHN, Ashington Colliery, Morpeth, Northumberland.

FALCON, MICHAEL, New Sinkings, Ynysddu, Monmouthshire.
FARNSWORTH, E., Pye Hill Villas, near Nottingham.
FEARNLEY, TOM, 1, Dawgreen Avenue, Crigglestone, near Wakefield.
FEWSTER, JOHN, 4, Belgrave Terrace, Felling, R.S.O., Co. Durham.
FIELD, SAMUEL, 77, Cemetery Road, East Kirkby, Nottingham.
FINNEY, JOSEPH, Elswick Collieries, Newcastle-upon-Tyne.
FISHER, RICHARD, 56, Hamilton Road, Hanley, Staffordshire.
FLETCHER, HERBERT, Hardwick Collieries, Heath, Chesterfield.
FORD, THOMAS, Blaydon Burn Colliery, Blaydon-upon-Tyne.
FORSTER, FRANK, 22, Gowland Terrace, Wheatley Hill Colliery, Thornley, R.S.O., Co. Durham.
FOULSTONE, HERBERT. Borough Foundry, Barnsley.
FOX, JOHN, Littleton Collieries, Huntington, near Stafford.
FULLER, F., Stone Bank House, Kidsgrove, Stoke-upon-Trent.

GALLAGHER, PATRICK, Clifton Row, Netherton Colliery, Northumberland.
GLASS, ROBERT WILLIAM, Craigielea, Whickham, R.S.O., Co. Durham.
GOODMAN, JOHN, Creswell, Mansfield.
GOODWIN, GEORGE, 71, Hammersley Street, Hanley, Staffordshire.
GORDON, GEORGE STOKER, 24, Louisa Terrace, Stanley, R.S.O., *via* Chester-le-Street.
GRAHAM, CECIL, Sunniside, Tow Law, R.S.O., Co. Durham.
GREENWELL, ALAN LEONARD STAPYLTON, Windlestone Colliery, Ferryhill, Co. Durham.
GROVES, HENRY, Glapwell Colliery, Chesterfield.

HALL, GEORGE, Broomhill Villa, Old Whittington, Chesterfield.
HALL, JOSEPH PERCIVAL, Edmondsley Colliery, Chester-le-Street, Co. Durham.
HALL, ROBERT WILLIAM, 1, Railway Street, Murton Colliery, Sunderland.

HAMPSON, ALEXANDER, St. Helen's Colliery, Bishop Auckland.
HANDYSIDE, WILLIAM, Jun., 4, Brandling Terrace, Felling-upon-Tyne.
HARBIT, WILLIAM DENHAM, Chopwell, Ebchester, R.S.O., Co. Durham.
HARDY, WILLIAM HENRY, Holly Cottage, Shipley, Derby.
HARE, GEORGE, Seghill Colliery, Northumberland.
HARRISON, GEORGE, High Park Colliery, Greasley, Nottingham.
HARVEY, JOHN ROGER, Moor Lane, Ockbrook, Derby.
HAWES, GEORGE ARTHUR, 29, Dene Terrace, Murton Colliery, *via* Sunderland.
HAYWOOD, FRED., Glapwell Colliery, Chesterfield.
HENDERSON, WILLIAM, 4, Beatrice Terrace, New Herrington, Fence Houses.
HENSHAW, JOHN, Butterley Park, Butterley, Derby.
HERRIOTTS, JOSEPH GEORGE, Shampore Colliery, Nirshachatti P.O., *via* Barakar, E.I.R., Bengal, India.
HERRON, EDWARD, 4, Holly Terrace, Stanley, R.S.O.
HESLOP, WILLIAM, Hunwick, Willington, Durham.
HILL, ROBERT, Norton Colliery, Smallthorne, Burslem, Staffordshire.
HINDS, H., Bentley Colliery, near Doncaster.
HORNSBY, DEMSTER, Choppington Colliery, Scotland Gate, R.S.O., Northumberland.
HOWE, JAMES, Jun., 80, Front Street, Bebside, Northumberland.
HUMBLE, JOHN NORMAN, West Pelton House, Beamish, R.S.O., Co. Durham.
HUNTER, ANDREW, 2, Abbotsford Terrace, South Shields.
HUTCHINSON, W., c/o Jos. Booth, Clough Gate, Grange Moor, Wakefield.

IMRIE, HENRY MARSHALL, 22, Western Hill, Durham.

JACKSON, ELIJAH, Langwith Colliery, Mansfield.
JAEGER, BERNARD, Heathfield, 6, Brondesbury Road, London, N.W.
JAMES, ALEXANDER A., Croxdale, near Durham.
JEFFERY, ALBERT JOHN, 6, Bowlby Street, Houghton-le-Spring, R.S.O., Co. Durham.
JOBES, RALPH ANDERSON, 13, Douglas Terrace, Carley Road, Southwick, Sunderland.
JOHNSON, WILLIAM, Framwellgate Moor, Durham.

KELLETT, ROBERT, Orchard House, Escombe, Bishop Auckland.
KIRBY, MATTHEW ROBSON, c/o A. L. Steavenson, Holywell Hall, Durham.
KNIGHT, FRANCIS W., Hartshill, Stoke-upon-Trent.
KNIGHT, WILLIAM JAMES, 2, Front Street, Easington Colliery, Castle Eden, R.S.O., Co. Durham.
KNIGHTON, JAMES, Tinsley Park Colliery, Sheffield.

LAWTON, FRANK, Wall Street, Ripley, near Derby.
LAWTON, THOMAS ARTHUR, The Firs, Teversall, near Mansfield, Nottingham.
LIDDELL, CHRISTOPHER, Kimblesworth Colliery, Chester-le-Street, Co. Durham.
LIGHTLEY, JOHN, Byers Green, Spennymoor, Durham.
LIVINGSTONE, ROBERT, Lethbridge, Alta. Canada.
LOGAN, REGINALD SAMUEL MONCRIEFF, 20, Boyd Terrace, Blucher Pit, Newburn, R.S.O., Northumberland.
LONGDON, ALBERT, Newthorpe, Notts.
LONGRIDGE, JOHN, 27, Mary Agnes Street, Coxlodge, Gosforth, Newcastle-upon-Tyne.

MCGREGOR, JOHN EDWARD, 21, Theresa Street, Stanley, R.S.O., Co. Durham.
MARLEY, FREDERICK THOMAS, Sitalpore Colliery, Dishagarh, Barakar, E.I.R., Bengal, India.
MARSHALL, JOHN JOSEPH, 14, Fairford Terrace, Stanley, R.S.O., Co. Durham.
MASON, BENJAMIN, Burnopfield Colliery, Burnopfield, R.S.O., Durham.
MELLOR, WILLIAM, Warmwell Lane, Marehay, Derby.
MELVILLE, JOHN THOMAS, 17, Elsdon Road, Gosforth, Newcastle-upon-Tyne.
MERIVALE, CHARLES HERMAN, Radcliffe, Acklington, Northumberland.
MILBURN, EDWIN WALTER, Canklow Cottage, Rotherham.
MILBURN, WILLIAM, Birtley White House, near Chester-le-Street.
MILBURNE, JOHN ETHERINGTON, Redworth Road, New Shildon, Darlington.
MILLER, ALEXANDER, Woonona, near Sydney, New South Wales.

MINNS, THOMAS TATE, Jun., Shildon House, Shildon, R.S.O., Co. Durham.
MINTO, GEORGE WILLIAM, Coolbawn, Castlecomer, Co. Kilkenny, Ireland.
MITCHELL-WITHERS, WILLIAM CHARLES, P.O. Box 2969, Johannesburg, Transvaal.
MITCHESON, HARRY, Florence Colliery, Longton, Staffordshire.
MORLAND, THOMAS, New Herrington, Fence Houses.
MORRIS, GEORGE BAILEY, 1, The Lyons, Hetton-le-Hole, R.S.O., Co. Durham.
MORRIS, H. S., c o Leo Mund, Hobart Building, 532, Market Street, San Francisco, California, U.S.A.
MORSON, FARRER WILLIAM, Glenholm, Crook, R.S.O., Co. Durham.
MOULD, J. E.. Berryhill Colliery, Stoke-upon-Trent.
MULLINS, WILLIAM, 48, Eland Street, New Basford, Nottingham.
MUSGROVE, WILLIAM, Heddon Colliery, Northumberland

NAISBIT, JOHN, 48, Tudhoe Colliery, Spennymoor.
NAYLOR, ALFRED, Ibstock Collieries, Leicester.
NELSON, GEORGE CATRON, Garesfield Colliery, near Lintz Green, R.S.O., Co. Durham.
NESBIT, JOHN STRAKER, Marley Hill Colliery, Swalwell, R.S.O., Co. Durham.
NIXON, JOHN, Baddesley Colliery, near Atherstone, Warwickshire.
NIXON, ROBERT, 11, Hight Street, Brindley Ford, Stoke-upon-Trent.

O'KEEFE, JOHN EDWARD, 10, Newburgh Street, Amble, Acklington, Northumberland.
OWEN, HERBERT, New Villas, Cross Heath, Newcastle, Staffordshire.
OWEN, WILLIAM ROWLAND, The Sangli Gold-mines, Limited, Gadag, Bombay Presidency, India.
OXLEY, F., Baddesley Collieries, near Atherstone, Warwickshire.

PARKIN, THOMAS WAKEFIELD, 17, Gowland Terrace, Wheatley Hill Colliery, Thornley, R.S.O., Co. Durham.
PARKINS, JOHN, Swiss Villas, Clay Cross, Chesterfield.
PARKINSON, THOMAS. Sneyd Colliery, Burslem, Staffordshire.
PARKINSON, W., 6, Ivy Terrace, South Moor, Chester-le-Street.
PARRINGTON, THOMAS ELLIOTT, Hill House, Monkwearmouth.
PATRICK, J. A., West Pool Villas, Saltergate, Chesterfield.
PATTERSON, THOMAS.
PATTISON, CHARLES ARTHUR, High Grange, Howden-le-Wear, R.S.O., Co. Durham.
PATTISON, WILLIAM, Clydesdale Colliery, Wolvehoek, Orange River Colony, South Africa.
PEARSON, C., Whitfield Colliery, Norton-in-the-Moors, Stoke-upon-Trent.
PEARSON, JOHN CHARLTON, Swiss Cottage, Westerhope, Kenton, Newcastle-upon-Tyne.
PEDELTY, SIMON, Hemsworth Collieries, Kinsley, near Wakefield.
PEEL, GEORGE, Jun., 27, Langley Street, Langley Park, Durham
PHELPS, CHARLES, c/o Darby and Company, Sandakan, British North Borneo.
POTTS, LAURANCE WYLAM, The Leam, Felling, R.S.O., Co. Durham.
PRATT, GEORGE ROSS, Springwell Colliery. Gateshead-upon-Tyne.
PROCTOR, THOMAS, Woodhorn Colliery, Morpeth.

RAINE, FRED. J., Wellington House, Birtley, R.S.O., Co. Durham.
RAMSAY, JOHN GLADSTONE, Page Bank Colliery, *via* Spennymoor, Co. Durham.
RAWSON, GEORGE, c/o George Alfred Lewis, Albert Street, Derby.
REES, J. H.
RICHARDSON, SYDNEY.
RICHARDSON, WILLIAM, Pleasley Colliery, Mansfield.
RIDLEY, GEORGE D., Medomsley, R.S.O., Co. Durham.
RIVERS, JOHN, Bow Street, Thornley Colliery, Durham.
ROBINSON, F. H., Blackwell Collieries, Alfreton.
ROBINSON, JOHN WILLIAM, Callerton, Kenton, Newcastle-upon-Tyne.
ROBINSON, JOHN WILLIAM, 3, Victoria Terrace, East Boldon, *via* Sunderland.
ROBSON, WILLIAM, Jun., Durham House, Hanham, Bristol.
ROCHESTER, WILLIAM, Ryton Barmoor, Ryton-upon-Tyne.

ROCHESTER, WILLIAM SIMM, Wellington House, Edmondsley, Chester-le-Street, Co. Durham.
ROEBUCK, WALTER, Talk-o'-th'-Hill Colliery, Talke, Stoke-upon-Trent.
RONTREE, J. H., 61, Heron Street. Fenton, Stoke-upon-Trent.
ROSCAMP, JOSEPH CRESSWALL, Ravensworth Colliery, Low Fell, Gateshead-upon-Tyne.
RUSSELL, DANIEL, Garriongill Colliery, Overtown, Wishaw, N.B.

SALT, W. G., Norton Colliery, Smallthorne, Stoke-upon-Trent.
SANER, CHARLES B., Village Deep, Limited, P.O. Box 1176, Johannesburg, Transvaal.
SCHOLLICK, THOMAS, 13, Model Street, New Seaham, *via* Sunderland.
SEARSTON, J., Pentrich Colliery, Derby.
SEED, ALEXANDER, 1, College Terrace, Brandon Colliery, R.S.O., Co. Durham.
SELLERS, GEORGE, 24, Church Drive, Shirebrook, Mansfield.
SEVERS, JONATHAN, Stanley, R.S.O., Newcastle-upon-Tyne.
SHAW, EDGAR H., Park Lane, Congleton, Cheshire.
SHAW, RALPH, Lower Chaplin Road, Florence, Longton, Staffordshire.
SHENTON, GEORGE, 106, London Road, Chesterton, Staffordshire.
SIMPSON, RICHARD CHARLTON, Wellington Terrace, Edmondsley, Chester-le-Street, Co. Durham.
SMALLWOOD, PERCY EDMUND, Chopwell Colliery, Lintz Green, R.S.O., Co. Durham.
SNOWDON, THOMAS, Jun., Oakwood, Cockfield, R.S.O., Co. Durham.
SOAR, CHARLES R., Granville Colliery, Swadlincote, Burton-upon-Trent.
SOUTHERN, STEPHEN, Heworth Colliery, Felling, R.S.O., Co. Durham.
SPROSON, ALBERT, Florence Colliery, Longton, Staffordshire.
STARK, JOHN, Woodside Colliery, Netherburn, Lanarkshire.
STOBART, THOMAS CARLTON, Ushaw Moor Colliery, Durham.
STOKER, NICHOLAS, South Pelaw Colliery, Chester-le-Street, Co. Durham.
STOKOE, JOHN GEORGE, Station Road, Birtley, R.S.O., Co. Durham.
STONE, EDWARD, Cotes Park, Alfreton.
SUTTON, HENRY, Biddulph Valley Collieries, Stoke-upon-Trent.
SWAN, WILLIAM EDWARD, Washington Colliery, Co. Durham.
SWORD, WILLIAM, Hall's Collieries, Swadlincote, Burton-upon-Trent.

TATE, THOMAS, Hardwick Collieries, Heath, Chesterfield.
TAYLOR, HERBERT WILLIAM, El Bote Mine, Zacatecas, Mexico.
TEASDALE, THOMAS, St. George's Colliery, Hatting Spruit, Natal, South Africa.
THORNLEY, GEORGE WILLIAM, 4, Central Drive, Shirebrook, Mansfield.
TOMLINSON, F., P.O. Box 92, Vryheid, Natal, South Africa.
TURNBULL, WILLIAM, West Holywell, Backworth Colliery, Northumberland.
TURNER, GEORGE, Tindale Terrace, Roachburn Colliery, Brampton Junction, Carlisle.
TURNER, PETER, Shelton Collieries, Stoke-upon-Trent.
TWEDDELL, JOHN SMITH, Seaton Delaval Colliery, Northumberland.

URWIN, JOHN, Inkerman House, Usworth Colliery, Co. Durham.
URWIN, THOMAS, Dipton Colliery, Lintz Green, R.S.O., Co. Durham.

VARLEY, JOHN, Walker Street, Eastwood, Notts.

WAINWRIGHT, WILLIAM, Heworth Colliery, Felling, R.S.O., Co. Durham.
WALKER, GEORGE, Hickleton Main Colliery, near Barnsley.
WALKINSHAW, DAVID, 50, Montgomery Place, Newton, Glasgow.
WALTON, ARTHUR JOHN, Bettisfield Colliery, Bagillt, North Wales.
WALTON, HARRY, Durham Road, Consett, R.S.O., Co. Durham.
WELSH, ARTHUR, Red House, Tunstall Village, near Sunderland.
WHELDON, ERNEST, Shipley, Derby.
WHITEHURST, HENRY, Grange Colliery, Burslem, Staffordshire.
WHITFIELD, THOMAS CUTHBERT, Bebside Colliery, Northumberland.
WIDDAS, FRANK, Ashcroft, Bishop Auckland.
WILBRAHAM, AARON, Ashwood House, Portland Colliery, Kirkby-in-Ashfield, Nottingham.
WILBRAHAM, G. H., Market Street, Clay Cross, Chesterfield.

WILKINSON, JOHN WILLIAM, South Durham Cottages, Eldon Old Pit, Bishop Auckland.
WILLIAMS, WILLIAM, Stanford Merthyr Colliery, West Maitland, New South Wales.
WILLIAMSON, HENRY EDWARD, 17, Holland Road, Sheepbridge, Chesterfield.
WILLIS, HENRY STEVENSON, Medomsley, R.S O., Co. Durham.
WILSON, CHRISTOPHER, 40, Morris Street, Birtley, R.S.O., Co. Durham.
WILSON, HUGH, 18, Grange Villa, Chester-le-Street, Co. Durham.
WILSON, JOHN, 20, North Glencraig, Lochgelly, N.B.
WOODWARD, WILLIAM, Lancashire Electric Power Company, 196, Deansgate, Manchester.
WRIGHT, WILLIAM, Pollington Colliery, New Brinsley, Eastwood, Nottingham.

YATES, THOMAS, Brynkinalt Collieries, Chirk, North Wales.
YOUNG, GEORGE ELLIS, Findon Hill, Sacriston, Durham.

Students.

Stud.Inst.M.E.

Students shall be persons who are qualifying themselves for the profession of mining, metallurgical, or mechanical engineering, or other branch of engineering, and such persons may continue Students until they attain the age of twenty-five years.

ALDERSON, WILLIAM, 48, Oldham Road, Dudley, Worcestershire.
ANGUS, ROBERT LAWRENCE, Dalblair Lodge, Old Cumnock, N.B.
ATKINSON, C. A., Barlaston, Stoke-upon-Trent.

BAINBRIDGE, OSWALD JEFFERSON, Sherwood Hall, Mansfield.
BANNATYNE, CLAUDE, c/o The Dunderland Iron Ore Company, Guldsmedvik-i-Raven, Norway.
BARBER, FRANK S., Sherwood Colliery, Mansfield.
BATTLE, FREDERICK ALWYN, 18, Clarendon Road, Leeds.
BELL, HAROLD PERCY, Clyvedon, Cleadon, Sunderland.
BLAKE, GEORGE CYRIL, Wellfield, Llanelly, South Wales.
BLANDFORD, THOMAS, Deafhill Colliery, Trimdon Grange, R.S.O., Co. Durham.
BLUNT, R., Blaby Hill, Leicester.
BRANDON, GEOFFRY, 9, Kensington Gardens, Monkseaton.
BRANFIL, CAPELL LISLE AYLETH, Dinnington Main Colliery, Rotherham.
BROWN, EDWARD OTTO FORSTER, Springfort, Stoke Bishop, near Bristol.
BURROWS, E. O., 53, Burford Road, Nottingham.

CAMPBELL, WILLIAM, Parkgrove Cottages, Plains, Airdrie, N.B.
CASHMORE, S. B., Ivy House, Perry Barr, Birmingham.
CAUSTON, GEOFFREY THEODORE, Shemwell Farm, Heath, Chesterfield.
CHALLANDS, R. S., Tibshelf Collieries, Alfreton.
CLARK, C. H., Estate Offices, Newton-le-Willows, Lancashire.
CLIVE, LAWRENCE, Chell Lodge, Tunstall, Staffordshire.
COCKS, JOHN, Newdigate Colliery, Bedworth, Nuneaton.
COLE, JOHN ARTHUR, Endon, Stoke-upon-Trent.
CORK, F. L., Jun., Equitable Coal Company, Limited, Dishergarh P.O., Barakar, E.I. Railway, Bengal, India.
CRANKSHAW, HUGH M., 10, St. Paul's Road, Withington, Manchester.
CROLE, ANGUS BREMNER, Colliery Office, Sanquhar, R.S.O., Dumfriesshire.
CROSSLEY, JOSEPH H., Sunset View, Thornhill, Dewsbury.

DAY, P. F., The Hollies, Sutton-in-Ashfield, Mansfield.
DEANE, J. R., Yew Tree House, Norton Green, Stoke-upon-Trent.
DIXON, GEORGE, Seghill Colliery, Seghill, Northumberland.
DOUGLAS, ALBERT EDWARD, Usworth Hall, Co. Durham.

EARDLEY, H. V., Whitfield Colliery Office, Norton-in-the-Moors, Stoke-upon-Trent.
ELLIOT, ARTHUR, 13, Eldon Place, Newcastle-upon-Tyne.
ELLIS, FRANCIS HENRY, Sherwood Colliery, Mansfield.

FIELD, BENJAMIN STARKS, 6, South View, Annfield Plain, R.S.O., Co. Durham.
FORRESTER, ROBERT HENRY, Auchenreoch Mains, Milton of Campsie, Glasgow.
FOSTER, HAROLD T., Rose Cottage, Kilburne, near Derby.
FOWLER, ROBERT NORMAN, Usworth Villa, Great Usworth, Washington, R.S.O., Co. Durham.

GALLOWAY, JOHN, Hebburn Colliery, Newcastle-upon-Tyne.
GIDNEY, WILLIAM HENRY, 9, Ravensbourne Terrace, South Shields.
GILCHRIST, GEORGE ATKINSON, 17, Eldon Place, Newcastle-upon-Tyne.
GOULD, CHALKLEY VIVIAN, Voryn, Trentham Road, Longton, Staffordshire.
GREENWELL, GEORGE HAROLD, Herbert Villa, Mountenoy Road, Rotherham.

HAFIZ, ABDUL, The University, Birmingham.
HARK, JAMES ROBERT, 92, Market Street, Hindley, near Wigan.
HARPER, GEORGE OCTAVIOUS, Greenhead, Chopwell Colliery, Lintz Green, R.S.O., Co. Durham.
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TRANSACTIONS

OF

THE INSTITUTION

OF

MINING ENGINEERS.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD AT THE HOULDSWORTH PIT, DALMELLINGTON, AUGUST 6TH, 1904.

MR. ROBERT THOMAS MOORE, PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting were read and confirmed.

The following gentlemen were elected:--

MEMBER -

Mr. ROBERT INGLIS ROBERTSON, 4, Clairmont Gardens, Glasgow.

ASSOCIATE—

Mr. J. STANLEY BROWN, Ecum Secum Bridge, Halifax, Nova Scotia.

STUDENT—

Mr. IRVINE LAURIE HOUSTON, Ecum Secum Gold-fields, Limited, Halifax, Nova Scotia.

Mr. William Smith's "Description of Houldsworth Colliery, Dalmellington," was held as read, as follows:—

DESCRIPTION OF HOULDSWORTH COLLIERY, DALMELLINGTON.

By WILLIAM SMITH.

Houldsworth colliery, the property of the Dalmellington Iron Company, Limited, is situated in the parish of Dalrymple and about 10 miles south-east of the county-town of Ayr. The colliery is connected by 2 miles of private railway with the company's ironworks, where the output is used in the making of pig-iron.

Shafts.—The two shafts, 50 feet apart, are sunk immediately over the outcrop of the Burnfoothill blackband-ironstone, in the Carboniferous Limestone series. The Millstone Grit, 45 feet thick, was passed through in the shaft at a depth of 300 feet, and the four principal limestones, varying in thickness from 4 to 10 feet, at depths of 402, 642, 942 and 1,074 feet respectively. No workable seams occur in these lower measures until the Thick coal-seam is reached, 300 feet above the Main or Mountain Limestone.

The downcast shaft, from which the output is drawn, is 1,230 feet deep, and measures 21 feet by 10½ feet inside the barring. It has three divisions, two of 8¾ feet each for the cages, and one of 22 inches for haulage-ropes, etc.

The upcast shaft, 1,248 feet deep, measuring 12½ feet by 11 feet inside the wood, has also three divisions, two of 4 feet each for the cages, and one 12½ feet by 6½ feet for the pumps. It was expected that a considerable quantity of water would be met with when sinking, hence the large space provided for pumps; but, fortunately, very little water was got, and big pumps were not required.

Winding-engines, etc.—The winding-engine, on the downcast shaft, has two horizontal coupled cylinders, 28 inches in diameter by 6 feet stroke, fitted with balanced slide-valves of

ordinary type. The drum, 15 feet in diameter, is fitted with foot- and steam-brakes. The ropes, 1½ inches in diameter, are made of galvanized plough-steel, with a galvanized-iron core, owing to the quantity of sodium chloride found in the water. The cages are made of steel, with oak bottoms, and carry 4 steel tubs, on one deck. The working-load, including the rope, is 8½ tons. The pithead-frame is of pitchpine, with upright legs, 20 inches square and 53 feet long; and back-stays, 20 inches by 14 inches and 74 feet long. The pithead-pulleys are 14 feet in diameter.

The winding-engine, on the upcast shaft, has two horizontal coupled cylinders, 18 inches in diameter by 3 feet stroke, fitted with Frew balanced slide-valves. The drum is 12 feet in diameter. The rope is 1 inch in diameter.

Steam is supplied from 4 Lancashire boilers, 30 feet in length by 8 feet in diameter, built for a working pressure of 120 pounds per square inch. The chimney is 140 feet high, and 6 feet in inside diameter at the top: the outside course of brickwork being built and pointed with cement.

Ventilation.—The Waddle fan, of improved type, 18 feet in diameter to the tips of the blades, at 70 revolutions per minute, produces 68,000 cubic feet of air with a water-gauge of 1 inch.

Haulage.—The main and main-and-tail rope systems are in use, worked from the surface by an engine with two cylinders, 20 inches in diameter and 4 feet stroke, geared 3½ to 1. There are four drums, each 6 feet in diameter.

Lighting.—The lighting of the colliery on the surface and underground is supplied by an engine, with a cylinder 9 inches in diameter and 14 inches stroke, driving a dynamo giving an output of 65 ampères at 200 volts.

Screens.—The screening-plant comprises two jigging-screens, with circular tumblers, distributing jiggers, plate picking-tables, nut conveying-table, dross-conveyor, and one dross scraper-conveyor, 182 feet long, carrying small dross to the boilers. The structure is supported on brick walls and has a framework of rolled steel H beams. The housing is of corrugated iron.

Electric Power-plant.—The electric power-plant, just started, consists of a Parsons steam-turbine, coupled direct to a continuous-current dynamo, and gives an output of 200 kilowatts at 500 volts and 3,500 revolutions per minute.

A description of this type of turbine is already printed in the *Transactions*, but as this is the first plant erected for colliery-work in Scotland, a few details of the plant may be mentioned. The machine is of the latest improved, parallel, compound type, adapted for the full range of expansion from the initial to the condenser-pressure. It is designed for a working steam-pressure of 100 pounds per square inch. The lubricant is forced under pressure to all the bearings, by a pump working from the turbine-shaft, all bearings being connected together and to the oil-reservoir, by means of pipes, 3 inches in diameter. The governor, of the mechanical centrifugal type connected to intermittent mechanism, is arranged to maintain a constant speed. It is fitted with hand regulating-gear, so that the speed may be adjusted 10 per cent. up or down while the machine is running. The ejector-condenser, used to give the vacuum, was adopted, because, for a number of months in the year, a sufficient quantity of surface-water can be collected at the necessary height. A vacuum of 26½ inches is obtained with the load on the turbine.

The dynamo is compound-wound and of ample size to allow of running over long periods, without undue heating.

The electric current is conveyed to the pit-bottom with cables comprizing 61 wires of 0·084 square inch area, vulcanized and armoured with two layers of galvanized wire. They are supported in the shaft with pitchpine cleats, 6 feet long by 12 inches wide, fixed to the buntons, at intervals of 120 feet.

No trials of the efficiency of this plant have been made, but the tests, recorded in Table I., were carried out in the presence of the Dalmellington Iron Company's engineer at Messrs C. A. Parsons and Company's works, Newcastle-upon-Tyne.

At present, the current from the turbine is taken to a Riedler pump at the shaft-bottom and to a three-throw pump in the south dook: this takes up less than half the power available, and that which is in reserve will be used to duplicate the shaft-pump or for haulage-purposes, if required.

The Riedler pump raises 150 gallons per minute against a

TABLE I. CONSUMPTION-TEST OF TURBO-GENERATOR, No. 948, ON MARCH 18TH, 1904.

Time of Observations.			Duration for 370 Pounds of Coal.		Water Consumed per Hour.		Pressure per Square Inch at Stop-valve.	Cylinder-vacuum in Mercury-column.	No. of Revolutions per Minute.	Average Power.	Readings on Main Armature.		Readings on Main Armature field.	
					Total.	Per Kilowatt								
Hrs.	Mins.	Secs.	Mins.	Secs.	Pounds.	Pounds.	Pounds.	Inches.		Kilowatts.	Volts.	Ampères.	Volts.	Ampères.
						A.—FULL LOAD.								
10	32	33	Start.											
10	37	0	4	27	4,989	25·00	100	27·90	3,400	199·80	550	358	550	3·93
10	41	30	4	30	4,933	24·52	101	27·90	3,400	201·20	550	360	550	3·93
10	46	4	4	34	4,862	24·20	100	27·90	3,400	201·36	549	360	549	3·93
10	50	35	4	31	4,916	24·72	97	27 80	3,400	198·80	548	358	545	3·93
10	55	7	4	32	4,898	24·31	100	27·85	3,400	201·44	547	372	547	3·93
10	59	25	4	18	5,163	24·90	102	27·85	3,400	207·84	545	371	545	3·93
11	3	42	4	24	5,045	24·40	103	27·85	3,400	206·30	544	360	544	3·93
11	8	21	4	32	4,898	24·20	100	27·85	3,400	202·20	545	369	545	3·93
11	12	47	4	26	5,008	24·40	100	27·85	3,400	205·80	545	369	545	3·93
0	40	14*	for 3,330 lbs.		4,968	24·5	100	27·86	3,400	202·75	547	364	547	3·93
						B.—HALF LOAD.								
11	50	42	Start.											
11	58	15	7	33	2,939	28·50	102	28·00	3,400	103·20	535	202	534	3·78
12	5	44	7	29	2,966	29·20	102	27·95	3,400	101·86	533	200	533	3·78
12	13	21	7	37	2,914	28·65	103	27·95	3,400	101·70	532	202	532	3·78
12	20	51	7	30	2,960	29·01	102	28·00	3,400	102·00	533	202	533	3·78
12	28	13	7	22	3,013	29·30	102	28·05	3,400	102·82	531	201	531	3·78
12	35	52	7	39	2,901	28·60	100	28·00	3,400	101·93	530	201	530	3·78
12	43	18	7	26	2,986	29·40	101	28·00	3,400	101·76	530	202	530	3·78
12	50	40	7	22	3,013	29·50	100	28·00	3,400	102·00	530	202	530	3·78
0	59	58*	for 2.960 lbs		2,961	29·02	101	27·99	3,400	102·16	532	201·5	532	3·78

* Duration of test.

NOTES. Barometer, 29·75 inches. The rise in speed from full load to no load was 2½ per cent. The temperatures, after a run of 3 hours at full load, of 2½ hours at half-load, and of over quarter-load, were as follow:—

	Temperature. Degrees Fahr.	Rise of Temperature. Degrees Fahr.
Atmosphere ..	80	—
Armature ..	142	62
Commutator ..	119	39

	Temperature. Degrees Fahr.	Rise of Temperature Degrees Fahr.
Shunt field-coils	143	63
Series field-coils	108	28
Compensating field-coils	135	53

head of 1,280 feet. The shaft is 1,250 feet deep, but 30 feet is added to the head when the water is forced to the pond. supplying the condenser, which is necessary when the supply of surface-water is inadequate. The pump-plunger is $3\frac{3}{8}$ inches in diameter with a stroke of 15 inches and runs at a speed of 120 revolutions per minute. It is driven by six cotton ropes, $1\frac{3}{4}$ inches in diameter, from a Westinghouse shunt-wound motor, of 90 brake-horsepower, running at 500 revolutions per minute. The ratio of the drive is 4 to 1. It has also a charger for the air-vessels, bye-pass valves, and a spring relief valve set to open at a pressure slightly in excess of the statical pressure of the column. The discharge column consists of steel pipes, 9 inches in diameter and $\frac{3}{8}$ inch thick, screwed and fitted with cast-steel flanges. This column was made of sufficient size to allow of the pump being duplicated.

The three-throw pump is of the Campbell all-bolt type, with plungers $4\frac{1}{2}$ inches in diameter and 9 inches stroke, to deliver 50 gallons per minute against a head of 600 feet. It is driven by belting from a motor of 15 brake-horsepower.

Underground.—The coal-field is very much broken up with a number of large and small faults, whin dykes, and, what is worse than either, bodies of floating whin, which seem to undulate through the strata. The whin sheets sometimes suddenly bend down and either take up the entire position of the coal-seam or leave it "burnt" and filled with whin boulders, thus rendering it useless over a considerable area. The coal occurs usually in three separate seams: at some places, the top seam is destroyed, leaving the middle and bottom seams clean; in others, it is the reverse.

The south level of the colliery had been driven 120 feet from the pit-bottom in clean coal, when the coal became "burnt," and got gradually softer until it was like soot. The roof and sides were supported with difficulty. After 120 feet had been cut in this material, a mixture of pieces of sandstone, shale, etc., lying at all angles, was penetrated; and this in a few feet gave place to green whinstone. This whin became very hard and in some parts was filled with ironstone balls. It was quite common for a miner's shift of 8 hours to be wholly occupied in boring, by hand, a hole $1\frac{1}{4}$ inches in diameter and 2 feet deep. A small

compressed-air plant was erected, capable of driving two rock-drilling machines. These were put to work, and Table II. shews

TABLE II.—COST OF DRIVING A GALLERY IN GREEN WHINSTONE.

Method of Drilling.	Length of Gallery Driven. Feet.	Time of Driving. Weeks.	Average Length of Gallery driven per Week. Feet.	Cost of Gallery per Fathom. £ s. d.
Hand ...	180	23	7·8	10 18 5·3
Machine ...	192	14	13·7	9 0 9·6

the difference between the cost of the portion driven by hand and that driven by the machine-drills. By using machine-drills, there was a weekly gain in cutting of 75 per cent., and a diminished cost of £1 17s. 7·7d. per fathom. This whin was afterwards proved to be a volcanic neck 540 feet in diameter. The overflow from it is traceable on the surface, 900 feet distant, and also in a bed of conglomerate, 108 feet thick, which was passed through in the shaft just under the soil. After cutting through the neck, the coal was got on the same level, but again "burnt" for a distance of 120 feet. A number of faults radiate from the volcanic neck, and become less in size as the distance from it increases. These difficulties are partly compensated for in the thickness of the coal, which, when found clean, may give over 20,000 tons per acre.

Table III. contains a section of the seams passed through in the shaft.

TABLE III.—SECTION OF THE STRATA SUNK THROUGH IN THE SHAFT.

Description of Strata.	Thickness of Strata. Ft. In.	Description of Strata.	Thickness of Strata. Ft. In.
Hard sandstone	76 0	Fakes	1 9
COAL, burnt	3 6	COAL, mid	5 4
Blaes and fire-clay	2 3	Blaes and fire-clay	4 0
COAL, top	7 3	COAL, bottom	5 9
COAL, parrot	0 5	Sandstone	—

These coals are worked on the threefold longwall principle, a description of which was given to the members by Mr. David Smith.* That is now a number of years ago, and a description of Houldsworth colliery would be incomplete without including its method of working.

The stones or brushings, between the coals, are found to vary widely in thickness, and this necessitates various modifications of the system of working. When the section is in its

* "A Three-fold Longwall Working at Jellieston Colliery, Dalmellington," *Transactions of the Mining Institute of Scotland*, 1892, vol. xiv., page 113.

best condition for a successful threefold working, the brushing between the bottom and mid, and the mid and top coals is about 3 feet thick. This gives sufficient débris to build the walls, but not sufficient to prevent the strata from settling gradually down.

The main levels may be driven either in the top or bottom coals, preferably the bottom, as this seam has a good roof and pavement. The branch roads, 36 feet apart and 12 feet wide, are driven direct to the rise of the strata, this gradient being 1 in 5; and are cut off at 300 feet by another cross-level driven from the heading. If these branches have been stowed and built with a 3 feet brushing, in 12 months' time, the buildings will be crushed into the roadway and the "cundy," leaving the mid coal down in the original position of the bottom coal.

The mid coal is now ready to be worked. As it is the softest coal of the three, if it is allowed to stand for a longer period than the time mentioned it is ground to powder. The same roads are again followed as in the first working, and brushed up to the bottom of the top coal.

When the cross-level is reached, and should it still be in use, a stoop is left for its protection, then the top coal is opened out and brought home as in back splinting. Pillars of old wood or stone are built behind to allow the roof of the waste to come down slowly.

During the first and second working, the coal forming the roof often creeps down so quickly that it requires to be ripped to allow of height for the hutches; but, as it is a coal-roof, no extra expense is incurred.

A number of years ago in the neighbouring pit, this seam gave a great deal of trouble from spontaneous combustion, and had to be abandoned. To guard against this danger, the levels of the Houldsworth colliery are driven in the low coal, 9 feet wide, with large stoops on each side; and advantage is taken of strips of whin and "burnt" coal, running parallel to the dip-and-rise, to form natural barriers, so dividing the workings into panels, that may be isolated in case of fire.

As an example of a change in the foregoing method of working due to an alteration of the section, the following descrip-

tion may be of interest. In a district to the rise, the strata had a section recorded in Table IV. In the first working, the fire-

TABLE IV.—SECTION OF STRATA IN A RISE DISTRICT.

Description of Strata	Thickness of Strata. Ft.	In.	Description of Strata	Thickness of Strata. Ft.	In.
Sandstone, from 70 feet to ...	100	0	Stone parting	0	1
COAL, smithy	3	6	COAL	2	6
Fire-clay	1	6	Stone mid	1	6
COAL, top	6	0	COAL	2	6
Stone, from 4 inches to ...	1	6	Fakey fire-clay	5	6
COAL	1	0	COAL, bottom	5	6

clay or brushing over the bottom coal, stowed the walls solid, with the result that the strata came down very little (Figs. 1 and 2, Plate I.). As it would not have been judicious to leave the upper coal under pressure for a long period, waiting on the strata coming down, the mid coal was opened out at the bottom of the old roads, on a bench, 8 feet above the rail-level. The removal of this mid coal to its full height, meant a working over 12 feet high on the road-head, and as the stone in the centre of the coal was 18 inches thick, it was decided to work the bottom portion of the coal and build the packs with the 18 inches of stone; and then to bring back the upper portion of the mid coal along with the top coal. Several places were tried in this way, but the method was not successful, as the buildings on the top of the bench, and the bench itself, were inclined to slide over into the roadway. This was very dangerous, and closed the road behind the men at the face.

Another district, with a somewhat similar section, has been opened out and another system adopted with more success (Figs. 3 and 4, Plate I.). After the first working had reached a large upthrow fault, the mid coal was opened out on the top of the bottom-coal brushing and taken out, 20 or 30 feet down the road. The back props were then drawn to within 6 or 8 feet of the face, thus allowing the top and smithy coal to fall from the rock. After this fall has taken place, the men climb upon the top of it, "sound" the rock, which is very hard and strong, and then take down any loose coal hanging on the face, ladders and long-shafted picks being provided for this purpose. The men thereafter proceed to fill the fallen coal. The smithy coal, which is usually "burnt," is clean here, so that a fall will

sometimes keep three men filling coals for 2 months. Five places, or a face 150 feet long, have been brought back in this way with little or no loss of coal. When the coal is all cleared away, the height of working measures about 30 feet, from the rail-level to the rock-roof. This is really a twofold working.

The method of drawing the hutches on the branch roads is also rather uncommon. The gradient, 1 in 5, being too heavy for a drawer to push up his hutch, advantage is taken of the weight of the loaded hutch in the following manner:—A single line of rails is laid in each road, and at the face a small chain-wheel, 9 inches in diameter, is fixed. One end of a $\frac{3}{8}$ inch chain is fixed to the loaded hutch, the chain is then passed round the wheel to the bottom of the road and the other end is fixed to the empty hutch. One of the colliers (there are two in each place) brings away the loaded hutch, and so draws up the empty one. When the hutches are within 20 feet of meeting, the collier and drawer push up the empty hutch, 10 or 12 feet, take off the chain and put the hutch on its side. The loaded hutch is then brought past, and stopped, the chain is put on to the empty hutch which is replaced on the rails; the loaded hutch then goes down to the level-road with the drawer, the collier returning to the face with the empty hutch. This system has been in use for a number of years, and gives every satisfaction.

Mr. Robert Thomas Moore's paper on "An Inburst of Waste-water at Wallyford Colliery," was held as read, as follows:—

AN INBURST OF WASTE-WATER AT WALLYFORD COLLIERY.

By ROBERT THOMAS MOORE.

The circumstances attending an inburst of waste-water, which took place at Wallyford colliery, near Musselburgh, on September 24th, 1903, are somewhat unusual, and it is thought that it might be of interest to put them on record.

The collieries of Wallyford and Carberry are about 1½ miles apart. They both work the Great seam of coal, and, to the dip of Carberry pits, there is a considerable area of waste, which, in 1903, was full of water.

Powerful shaft and dook-pumps were erected at Wallyford colliery, the pumping-station for the two fittings, and arrangements were made to take the water to them from Carberry waste. For this purpose, levels were driven towards it from Wallyford dook. When the waste was neared, a drift, 8 feet wide, was driven, with front and flank bore-holes in the usual way. The old plans were found to be wrong, and this caused some delay in making a connection; but, ultimately, No. 1 bore-hole (Fig. 1, Plate II.) was put through into the waste on July 2nd, 1903.

The bore-hole was 2½ inches in diameter and 75 feet long. It was placed near the middle of the seam, about 8 inches from the top of the 19 inches of soft coal (Fig. 3, Plate II.). A pipe, 6 feet long, was inserted and made tight in the bore-hole, and the water was allowed to run through a cock put on the end of it, in such quantity that it could be conveniently dealt with by the pumps. When the bore-hole was made, the recorded pressure was 175 pounds per square inch, and this corresponded with the head of water in the waste. The water was allowed to flow in this way for 7 weeks, boring-rods being put through the bore-hole, when the flow lessened.

On August 19th, 1903, the pressure had fallen to 75 pounds per square inch, and as enough water did not come through to

keep the pumps going, No. 2 bore-hole (Fig. 1, Plate II.) was made in the same part of the seam as No. 1 bore-hole. There was no cock put on this, the water being allowed to come through freely, and with the two bore-holes there was sufficient water to keep the pumps fully employed.

At this time, fresh feeders, amounting to 400 gallons a minute, were got in another section of the colliery; and both bore-holes were closed and the flow of water stopped for a week until additional pumps were installed. During this time, the pressure rose to 85 pounds per square inch; but, when the bore-holes were reopened, it fell continuously, until on September 23rd, 1903, it was 65 pounds per square inch. At this date, it was found that the water was gaining on the pumps, and the cock on No. 1 bore-hole was shut. The water still coming through too rapidly, a tapered plug, 12 feet long, was driven into No. 2 bore-hole on the early morning of September 24th, 1903; but it was found that this did not stop the flow of water, which issued from fissures in the coal round the bore-hole. An attempt was made to close these, but the volume of choke-damp, coming with the water, caused proceedings to be delayed until arrangements had been made to increase the air-current. At 11 a.m., while this was being done, the water burst through suddenly, filling the Wallyford dip workings and drowning the pumps. Fortunately, there was no loss of life, although, at the time of the inburst, men were at work at Wallyford, both in the connecting levels and in the dooks below them.

Arrangements were made to raise the water by means of electrically-driven centrifugal pumps, and the dip workings were cleared in April, 1904, after 1,000,000 tons of water had been pumped from them.

When the bore-holes were reached, it was found that a large opening, following the line of No. 2 bore-hole, had been made into Carberry waste. The shape of this opening is shewn in Figs. 1, 2, 3 and 4 (Plate II.). For about 40 feet (A to B) from the Carberry waste, the opening varied from 10 to 18 feet in width and 11 to 12 inches in height, the cavity being immediately below the position of the bore-hole; for 10 feet farther (B to C), the height was 4 feet 2½ inches, the bottom coal being removed down to the level of the parrot coal; for 30 feet down to the top of the drift, and for 75 feet farther down to a fault,

which had been crossed by a stone-drift (C to E), the opening varied from 27 to 2 feet in width, and all the coal down to the parrot coal had been removed and the roof had fallen.

No. 1 bore-hole was intact for a distance of 38 feet from Carberry waste.

The cause of the inburst was evidently the disintegration of the friable coal and fire-clay round No. 2 bore-hole. No doubt, much of the opening was made by the rush of the water while the inburst was taking place. This is shown by the spaces worn out at the turns, F, G, H and I (Fig. 1, Plate II.), where the current struck the soft coal, wearing it away in the middle part of the seam where it was eroded in the main cavity, B (Fig. 1, Plate II.). It is evident, however, that No. 2 bore-hole had been gradually widened, until the coal at the end was not able to keep back the water which finally burst through.

It is somewhat singular that No. 1 bore-hole should not have been worn away. There may have been some slight difference in the hardness of the coal through which it was made, although its distance from No. 2 bore-hole was only from 3 to 10 feet. Probably, the rush of water through it was not so great, as it was checked by the cock and the last 6 feet of it were protected by the tube. Whatever be the reason, the disintegration seems to have been almost wholly along the line of No. 2 bore-hole.

It is interesting to note that during 29 days (for that was all the time that the water was running through it), there was sufficient erosion to allow of the water bursting through a barrier of coal, 80 feet thick.

Possibly, had the bores been tubed throughout, there might have been no rubbing on the coal, and the inburst might not have happened.

DISCUSSION OF MR. JAMES R. WILSON'S PAPER ON A "PROPOSED METHOD OF SINKING THROUGH SOFT SURFACE."*

Mr. M. Walton Brown (Newcastle-upon-Tyne) wrote that the method of sinking described by Mr. J. R. Wilson had been tried in Germany about 16 years ago. The pumping-shaft at the Guerini colliery had been sunk to a depth of 20 feet, and

* *Trans. Inst. M.E.*, 1904, vol. xxvii., pages 86 and 239.

the further sinking was prevented by a large influx of water and sand.

The sinking was then resumed by the Haase system, by which a series of wrought-iron tubes are driven downward, side by side, so as to form a lining to the intended shaft. The shaft was a rectangle, 10·8 feet by 8·5 feet within the ordinary timbering, and reduced to 9·5 feet by 7·2 feet within the tubular lining. The single tubes were 13·1 feet long, with an internal diameter of 4·1 inches, and 0·2 inch thick. Wooden guides, with cast-iron cross-bars at the top and bottom, were attached to the timbering of the shaft, so as to ensure the tubes being driven vertically downward in the required positions. The depth to the coal-seam being 71 feet, six lengths of the tubes were used in the work, which commenced on May 24th, 1887, and the tubes reached the clay above the coal-seam on October 25th, 1887.

Sixty-four tubes were used, eighteen on each of the long sides, and fourteen on each of the short sides of the rectangular shaft. The work was completed in 225 working-shifts of 12 hours each; the items of cost being as under:—

Sets of Tubes.	Time occupied in driving.	Wages, including 2 Enginemen.	Length of Tubes inserted.	Cost per Foot of Tube inserted.
		£ s. d.	Feet.	s. d.
1	May 24th to June 8th, 1887	21 12 6	688	0 7·54
2	June 9th to June 22nd, 1887	18 15 0	781	0 5·76
3	June 23rd to July 7th, 1887	18 6 6	794	0 5·54
4	July 8th to August 13th, 1887 ...	33 11 9	777	0 10·37
5	August 14th to September 18th, 1887	39 0 3	797	0 11·74
6	September 19th to October 25th, 1887	36 11 9	603	1 2·56
Totals		£167 17 9	4,440	0 9·07
Two officials		53 17 3	—	0 2·91
Cost of 4,724 feet of tubes and tools ...		1,676 1 6	—	7 6·60
Coal for boilers		204 14 9	—	0 11·07
	Total cost	£2,102 11 3	4,440	9 5·65

The removal of the sand and the preparation of the permanent iron tubbing of the shaft were then proceeded with, and about 30 feet of the shaft were completed in November, 1887. The water was removed by two pulsometer pumps, at the rate of about 300 gallons per minute.*

* *Zeitschrift für das Berg- Hütten und Salinen-wesen*, 1888, vol. xxxvi., pages 225-226, and Plate VI.; and *Trans. N.E. Inst.*, 1889, vol. xxxviii., abs., page 29.

Mr. James R. Wilson wrote that he was much interested in perusing Mr. M. Walton Brown's description of a method of sinking through soft surface, shewing that a method similar to that which he had proposed, had actually been carried out successfully. He had every reason to believe that if the necessary steps were taken to ensure the absolute perpendicularity of the bore-holes, the method could be successfully adopted elsewhere as an alternative to the use of cast-iron or steel cylinders.

HOULDSWORTH PIT, OF THE DALMELLINGTON IRON COMPANY, LIMITED.

The members visited the Houldsworth pit, and were met by Mr. James P. Walker, the iron-works manager, Mr. William Smith, general mining manager, and the colliery officials; and were conducted by them over the works aboveground and underground.

A hearty vote of thanks was given to the Dalmellington Iron Company, Limited, and their officials.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,
HELD IN DOWELL'S ROOMS, EDINBURGH, OCTOBER 8TH, 1904.

MR. ROBERT THOMAS MOORE, PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting were read and confirmed.

The following gentlemen were elected:—

MEMBERS -

Mr. JAMES BLACK, Dunsyston Colliery, Airdrie.
Mr. JAMES BOYD, Queenzieburn Cottages, Kilsyth.
Mr. GEORGE CHAMBERS, 238, West George Street, Glasgow.
Mr. ANDREW F. CURRIE, 10, Scone Gardens, Parson's Green, Edinburgh.
Mr. DAVID GEMMELL, Coylton, Ayr.
Mr. ALEXANDER INNES, Plains, Airdrie.
Mr. SAMUEL LECKIE, Over Dalserf Colliery, Netherburn.
Mr. ROBERT LIVINGSTONE, 33½, Bell Street, Wishaw.
Mr. JOHN MASTERTON, Longrigg, Longriggend.
Mr. J. MONTGOMERY PEARSON, 51, John Finnie Street, Kilmarnock.
Mr. PETER TAYLOR SWORD, Cherry Bank, Newhaven Road, Leith.

ASSOCIATE MEMBER—

Mr. CHARLES AIR, 74, York Street, Glasgow.

The discussion of Mr. Douglas Jackson's paper on "Natural Coke in Douglas Colliery, Lanarkshire," was closed, and a vote of thanks was awarded to the author.

DISCUSSION OF MR. WILLIAM SMITH'S "DESCRIPTION OF HOULDSWORTH COLLIERY, DALMELLINGTON."*

Mr. T. H. MOTTRAM (H.M. Inspector of Mines) wrote that the panel of working, which the members of the Institute saw when visiting the Houldsworth colliery, was, he presumed, not

* *Trans. Inst. M.E.*, 1904, vol. xxviii., page 2.

the one described by Mr. Smith as having a face 150 feet in length and working backwards from an upthrow fault, though the section of coal being wrought was evidently the same in both cases. It would be interesting to know how far back from the fault the top coal could be worked without the rock breaking; when it did break, what effect it had upon the working-face and roadways; whether it did give ample warning; and whether any coal was lost through being buried by the rock.

There are in the working under review four seams or 21 feet of coal to 8 feet of dirt. The working of the bottom coal and the mid seam is simple enough, and may be compared to the method adopted in the working of the Splint and Virgin seams in some parts of the Lanarkshire coal-field: the roof being secured in a similar way. When, however, in order to work the two top seams at Houldsworth colliery, the timbering shewn in Fig. 4 (Plate I.) is drawn, letting down 11 feet more of coal and dirt, the panel is at once turned into a very high working, underneath a rock from 70 to 100 feet thick. Under a roof of a different character, this system could not be adopted; and it can only be followed so long as the roof remains good, for the obvious reason that it is practically impossible to secure such a roof owing to the great height and the want of proper footing for supports: the height being 30 feet from the rail-level to the rock, when the coal has been cleared. Mr. Smith pointed out that after the fall of top coal had taken place, the men climbed up and sounded the rock, which is "very hard and strong," and removed any loose coal hanging on the face. It seemed to him (Mr. Mottram) that overhanging pieces of coal must require considerable attention, more indeed than the rock itself, as the latter will probably give more warning before breaking.

One decided advantage of working on this system is evidently the extraction of practically all the coal, thus avoiding liability to spontaneous combustion, to be rid of which is no small matter, as past experience in the working of the Patna coal has shewn.

As to the method of drawing the hutches described by Mr. Smith, the only advantage seems to be the saving of a double line of rails; there might be a good reason for this, but he doubted whether there would be any saving, when the additional labour entailed by lifting the empty hutches on and off the road was taken into account.

The PRESIDENT (Mr. R. T. Moore) said that there were few places where they had an opportunity of working such thick seams as that at the Houldsworth pit, and in most cases there was a large amount of coal lost. In South Staffordshire, the Thick coal-seam was worked in panels, and then formed into small pillars, which were robbed; and he was under the impression that there was considerable loss of coal. The method employed at Patna was an attempt to work out the thick seam by successive longwall workings. A similar method had been successfully employed at Dysart. It seemed that the only economical way to work these thick seams was to divide them into successive longwall workings.

Mr. WILLIAM SMITH, replying to the discussion, wrote that the working-places, visited by the members when at Houldsworth colliery, were adjacent to the section described in his paper. The coal was worked back, 120 feet from the upthrow fault, before the rock shewed signs of breaking. Part of it came away, but only in places from nothing up to 7 feet thick and about 20 feet long. The main body of the rock was still standing, so that no crushing had taken place either at the faces or in the roadways. No coal whatever was lost, as the roof always kept up until all the coal was filled. There was no doubt that in the thick hard coarse sandstone lay the success of this high working.

The factor which made the three-fold working a success, namely, the crushing and quick coming together of the roadways, made it impossible to run the branches for any distance, where a double road is laid. The branches are "brushed" 10 to 12 feet wide and when a distance of 40 yards is attained, so quickly have the sides come together that there is only room for one hutch-road. The branches are generally cut off at intervals of 300 to 360 feet, and in order that they may reach that distance, only a single road is used.

The President (Mr. R. T. Moore) was awarded a vote of thanks for his paper on "An Inburst of Waste-water at Wallyford Colliery."

Mr. James C. Weir's paper on a "Fire in a Lanarkshire Colliery, and Description of a Condenser used thereat" was read as follows:—

FIRE IN A LANARKSHIRE COLLIERY, AND DESCRIPTION OF A CONDENSER USED THEREAT.

By JAMES C. WEIR.

Introduction.—The Glespin coal-field, in the Upper Coal-measures, has already been described by the late Mr. Robert Weir,* although he placed the seams in a different stratigraphical position from that now assigned to them. Since that paper was read, there has been a considerable amount of boring and prospecting carried on in the Glespin coal-basin. The annexed section (Table I.) compiled by the writer, would lead one to believe that the Glespin coal-seams are in the Upper Coal-measures, beginning with the Seven-feet or Ell down to the Shotts coal-seam. Of course, it is difficult to prove the exact stratigraphical position of these coal-seams, but from the nature of the roof and pavement and the characteristics of the coals, the writer has been led to compare them with the coal-seams indicated in the section. A striking peculiarity of this section is the almost identical similarity of the strata or rock above all the coal-seams except the Three-feet or Pyotshaw seam. When a fault occurs, it is almost impossible to identify the coal until the seam is opened out. The faults are very wide, the strata in passing through them are highly inclined—vertical in fact—and when the fault is cut through, the strata are found lying in their ordinary position.

The writer may state that, down to the Nine-feet or Splint coal-seam, the strata are a mixture of red and blue blaes, sandstones, etc., similar to the rocks of the New Red Sandstone series. About $\frac{3}{4}$ mile from the northern end of the coal-field, the above-mentioned seam is intersected by a fault with an upthrow of 24 feet to the south. The strata on the south side of this fault contain no red or blue blaes, although the coal-seams are easily identified with those on the north side. The strata, here, between the respective seams are much thinner than those shown in Table I.; in some cases, from 12 to 24 feet.

* *Trans. Inst. M.E.*, 1899, vol. xvi., page 436.

TABLE I.—SECTION OF STRATA AT GLESPIN COLLIERY, DOUGLAS, LANARK.

No.	Description of Strata.	Thickness of Strata. Ft.	Ins.	Depth from Surface. Ft.	Ins.
1	Strata	55	0	55	0
2	Mussel-band ..	0	7	55	7
3	COAL, wild parrot	3	0	58	7
4	Strata	59	0	117	7
	Ell or Seven-feet Seam—				
5	COAL, free, with splinty ribs: house coal ...	7	2	124	9
6	Strata	53	5	178	2
	Pyotshaw or Three-feet Seam—	Ft.	Ins.		
7	COAL, splinty ...	2	4		
8	Hard fakey clay ...	3	2		
9	COAL, free: steam ...	0	9		
		6	3	184	5
10	Strata	51	4	235	9
	Main or Four-feet Seam—	Ft.	Ins.		
11	COAL, free and firm: steam ...	2	2		
12	Daugh ...	0	6		
13	COAL, firm: steam ...	2	3		
		4	11	240	8
14	Strata	93	4	334	0
	Splint or Nine-feet Seam—	Ft.	Ins.		
15	COAL, firm and splinty	4	0		
16	Cannel or stone ...	0	6		
17	COAL, free and firm: house ...	6	2		
		10	8	344	8
18	Strata	42	0	386	8
19	COAL, free	0	6	387	2
20	Strata, with ironstones and mussel-bands above the coal	19	6	406	8
21	COAL, parroty ...	0	3		
22	COAL, free and firm	1	6		
		1	9	408	5
23	Strata	36	11	445	4
		Ft.	Ins.		
24	COAL ..	1	1		
25	Blaes ...	0	2		
26	COAL, firm	2	2		
		3	5	448	9
27	Strata	43	1	491	10
	Virtuewell Seam—	Ft.	Ins.		
28	COAL, parrot ...	0	8		
29	COAL, free	3	0		
		3	8	495	6
30	Strata, with Kiltongue mussel-band, ironstones, and a number of thin *coals* ...	89	0	584	6
31	Strata	27	1	611	7
	Kiltongue or Carmacoup Upper Seam—				
32	COAL, firm and free ...	3	8	615	3
33	Strata	65	3	680	6
	Upper Drumgray Seam—				
34	COAL, free and firm	1	2	681	8
35	Strata	60	0	741	8
	Lower Drumgray or Carmacoup Seam—	Ft.	Ins.		
36	COAL, free	2	1		
37	Daugh ...	0	2		
38	COAL, free	1	8		
		3	11	745	7
39	Strata	37	1	782	8
40	COAL, parrot ...	3	0	785	8
41	Strata	27	0	812	8
42	COAL, with partings of dirt ..	5	10	818	6
43	Strata	12	0	830	6
44	COAL	3	6	834	0

At Glespin colliery, the Seven-feet and Nine-feet are the principal seams, and yield first-class house-coal. In the writer's opinion, they are the Ell and Splint coal-seams respectively. They dip in a northerly direction at an average inclination of 1 in 4, and are worked stoop-and-room.

There is a considerable quantity of surface-water, which enters at the outcrop of the seams and finds its way into the dip workings, whence it is pumped to the hill and pit-bottoms respectively by Tangye special pumps.

The Seven-feet seam is entered by an ingoing-eye driven in the coal, dipping 1 in 4 for 780 feet. The seam rises to the outcrop in a semicircle. In winter, the average quantity of water varies between 300 and 400 gallons per minute; and it is pumped to the hill against a head of 270 feet by a Tangye special pump, with a steam-cylinder, 21 inches in diameter, and a pump 9½ inches in diameter by 36 inches stroke. The exhaust-steam was a great nuisance, and the temperature in the steam-drift and return airway attained 110° Fahr. and upwards, owing to the excessive heat. When repairs were required, it was necessary to stop the pump for some considerable time before the men could enter; consequently, the water rose in the dook, and the miners were thrown idle.

This state of matters being very unsatisfactory, a condenser (of which a description will be given later) was adapted to the pump; and, since then, the steam-drift can be entered at all times, as the temperature rarely exceeds 75° Fahr. The working is much pleasanter, the cost of repairs is greatly reduced, and a saving is effected in the upkeep of bucket-leathers, in addition to a saving of from 15 to 20 per cent. in the steam-consumption, as there is a vacuum of 10 pounds per square inch. The pump discharges a much larger quantity of water, due to this vacuum, thus preventing any slip on the suction-valves. The average pressure of steam at the pump is 42 pounds per square inch, or only 3 pounds less than at the boilers—a very satisfactory result.

Fire.—In the Nine-feet seam, the water is pumped against a head of 180 feet to the pit-bottom, whence it is forced to the surface by a pair of rams, 14 inches in diameter, together with the water collected in the sump from the rise-workings. The water from the dook in the seam is pumped by a Tangye special pump, and, as in the case of the Seven-feet seam, the exhaust-steam raised the temperature. A fire broke out, midway down the dook, in April, 1901, and whether it arose from that cause or from the accidental ignition of a screen or other material will remain a mystery. The fire spread with great rapidity, and the exploring party could make no headway, owing to the smoke and gases emitted from the fire.

It was then decided to flood the dook, in order to extinguish

the fire. The pits and all openings were closely battened down, and the Douglas Water, a stream which flows near the pit, was turned into No. 1 pit, the water being allowed to rise fully 72 feet in the shaft and up to the door-head in the upcast pit, which is 60 feet higher than No. 1 pit and to the rise of the same. After a few days' stoppage, the pumping-out of the water was begun, no smoke being visible, although there was a strong smell of gases. On the water being taken down to the door-head of No. 1 pit, smoke began to issue from the upcast pit, so it was decided to attempt exploration. When this could be done, a stopping between the two pits was opened. The head coal, 4 feet thick, had fallen, and was burning fiercely. All the other "ends," down to the bottom level, were examined with the same result. An effort was then made to get above the upcast pit, but the explorers were forced to retreat, owing to the smoke and gases which began to increase, as air from the outcrop and rise workings was constantly feeding the flames and it was impossible to cut it off.

It was then decided to flood the whole of the workings of the Nine-feet seam, and accordingly the Douglas Water was again turned into the mine until the water in the downcast shaft was level with the Seven-feet seam, there being now a height of 258 feet of water in this shaft. The taking out of the water with the ram-pumps and chests was recommenced, but it was a costly and tedious undertaking, owing to the packing of the rams failing and the midwall of the shaft continually giving way. Ultimately these difficulties were overcome, and the winding of coals from the Four-feet seam was started by the end of July. The Seven-feet seam, however, was working a month before this, for although the water in this seam was fully 480 feet up the dook, and the whole of the workings were under water, this was pumped out by a Tangye special pump, with a steam-cylinder 24 inches in diameter, and a pump 10 inches in diameter by 24 inches stroke, and work was begun immediately while the water from the other seams was being taken out. The whole of the Nine-feet workings where the fire occurred were closed and had to be re-opened, but as there was from 3 to 4 feet of head coal to work, it greatly facilitated matters. The chief difficulties were the pumping-out of the water; the heat, 80° Fahr. on the average; and the gases (principally carbonic acid gas) from the waste on both sides. The men were sometimes

thrown idle, in consequence of these difficulties, and it was early in 1903, or fully 19 months from the time that the fire started, before coal was being produced from the Nine-feet seam and then only to a very limited extent.

Steam-condenser.—The arrangement consists in combining with the usual form of steam-pump, A (Fig. 1), a second or auxiliary pump, B, by means of pipes, P, so that the water from the first pump, A, is discharged into the suction-pipe,

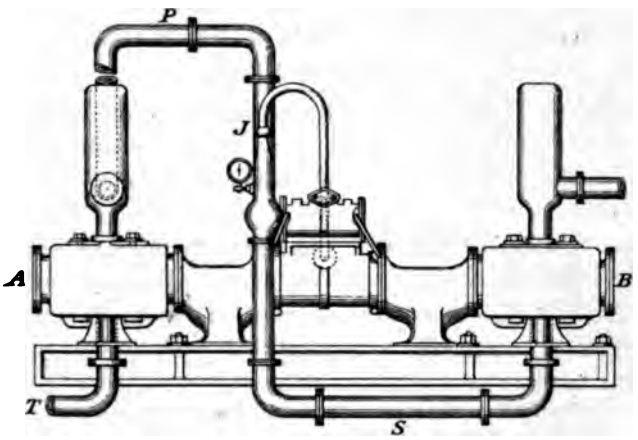

FIG. 1. SIDE ELEVATION.

S, of the auxiliary pump, B, where it meets, at J, the exhaust-steam from the steam-cylinder, and is effectively condensed; it is then drawn into the pump, B, and discharged where wanted. The piston and double-acting pump-buckets are fitted on a through rod. It is preferable that the buckets be solid piston-blocks, fitted with rings similar to those of the steam-piston, although the leather-buckets are not much injured by the exhaust-steam, as the temperature of the water is only slightly raised; but this, of course, depends upon the speed of the pump.

This condenser was intended to eliminate as far as possible the heat generated by the exhaust-steam from pumps in mines, and, as evidenced by the results obtained at Glespin colliery, this condenser acts in a most satisfactory manner, the temperature in the vicinity of the pump being reduced on an average 35°, that is from 110° to 75° Fahr.

In comparing this condenser with those in which the steam is turned direct into the suction or tail-pipe, the writer finds

that the former is the more satisfactory, as there is no difficulty with a head of water up to 270 feet, which is the limit that has been tried: whereas, in the case of the latter, the pump does not act satisfactorily, even before this head is reached. The writer's experience regarding upkeep, since adopting these condensers, shows a considerable saving in bucket-leathers and other parts of the pump, in addition to a decrease in the consumption of fuel owing to the reduced quantity of steam used.

QUALIFICATIONS FOR MINE-MANAGERS' CERTIFICATES.

Mr. JAMES HAMILTON introduced a discussion on The Coal-mines Act (1887) Amendment Act, 1903, in reference to its effect on the qualifications of candidates for certificates of competency.

After discussion, it was unanimously agreed that it be remitted to the Council of the Institute to draw up and forward to the Home Office a memorandum on the following lines:—

In the opinion of the Mining Institute of Scotland, the present system of examination by local examiners in each mining district has worked satisfactorily, and that to substitute examination by a central board on one set of examination papers for the whole country, as has been proposed, would be attended with very serious disadvantages in respect that (*a*) it would tend to put the granting of certificates exclusively into the hands of examiners who are not in continual touch with practical mining; (*b*) it would prevent each candidate from being efficiently tested on the conditions of mining peculiar to his own district, where the great majority of candidates are certain to remain; (*c*) the advantage of having an examination each month to which candidates can go forward would be lost; (*d*) there is no more need to seek for uniformity in the examination for mine-managers' certificates than in the examination for degrees in arts, science, or medicine.

A knowledge of ambulance-work might be required for a second-class certificate, but it should be secured by requiring candidates to produce a certificate of a recognized ambulance association, and not by adding that subject to the mining examination.

Nothing should be done to discourage evening class-work, as there are many cases where the daily employment, though it may not be such as to count for practical experience, is yet sufficient, taken along with private study or attendance at evening classes, to give the student as good, if not a better knowledge of mining than could be obtained by attendance at a mining course in a recognized college.

The SECRETARY, on behalf of the Council, submitted a draft lease of a new hall in Hamilton for the Institute, and it was approved.

THE SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING,
HELD AT THE UNIVERSITY, BIRMINGHAM, JUNE 13TH, 1904.

MR. ISAAC MEACHEM, PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting and of Council Meetings were read and confirmed.

The following gentlemen were elected:—

MEMBER—

Mr. EDWARD ALDERSON, Mining Engineer, Oakham Road, Dudley.

STUDENT—

Mr. JAMES WHITEHOUSE, Mining Student, Highfield House, Lichfield Road, Walsall.

Mr. ALEXANDER SMITH (Secretary) announced that he had received a communication from Mr. F. Brain, drawing attention to a leaflet dealing with malignant worm-disease (ankylostomiasis) which had been prepared by him at the request of the Gloucestershire County Council. This leaflet was being circulated by the County Council throughout the mining districts of the county. He further announced that the council had discussed the matter with Mr. W. N. Atkinson, H.M. inspector of mines, and a resolution had been passed that the matter should be brought to the notice of the county councils in the Midlands, with a request that a similar circular should be circulated by them among the colliers of their districts. The council further thought that colliery managers should satisfy themselves as to the good health of foreigners and others before giving them employment.

Mr. J. T. ONIONS read the following paper on "The Northern Portion of the Bristol Coal-field":—

THE NORTHERN PORTION OF THE BRISTOL COAL-FIELD.

By J. T. ONIONS.

The Bristol coal-field is situated partly in the county of Somerset and partly in Gloucestershire. The greatest length is about 15 miles and the greatest width from 4 to 6 miles, so that, compared with its neighbour and great rival the South Wales coal-field (the greatest length of which is 89 miles and greatest width 21 miles) it is a comparatively small field.

Geology.—The Coal-measures are covered by rocks of newer formation. In the New Red Sandstone, the chief deposit covering the northern portion of the coal-field, a very useful bed of marl is found cropping out at Shortwood and is being converted into bricks, etc., by the Shortwood Brick and Tile Company. This bed extends for a considerable distance in a northerly direction, and the soil lying immediately upon it is rich and fertile. These rocks in the neighbourhood of Pucklechurch have an altitude of 300 feet above sea-level.

The Coal-measures repose upon the Millstone Grit, which lies at an angle of 20 degrees dipping southward at the northern end of the coal-field, and on the eastern side at an angle of 30 degrees dipping westward. The Millstone Grit rests conformably upon the Carboniferous Limestone.

The northern portion of the Bristol coal-field produces household and gas coals, and the southern portion, steam and coking coals. In the present paper, the writer will deal with the northern portion, leaving the southern portion of the coal-field for a future communication.

The northern portion is a small but very interesting basin, about 5 miles long and about 2½ wide (Fig. 1, Plate III.). Coal has been extracted from this area for about 100 to 150 years, and, at the present time, the Coal Pit Heath collieries, Parkfield colliery, and possibly Shortwood colliery, are working

it with an estimated output of about 250,000 tons per annum, and probably all the workable coal will be exhausted in 40 or 50 years.

The Coal-measures at their outcrop, covered by rocks of newer formation, generally lie at an angle of about 26 degrees, which eases towards the middle of the basin from both sides.

The coal-field, situated near to the large and important towns of Bristol and Bath, is connected with both by the Midland railway. Until 1892, the old broad-gauge railway from the West of England ran to the collieries in this basin, connecting them with the important towns of the west, and thereby giving the owners a great advantage for the disposal of their output without any serious trouble. Since the broad gauge has given way to the narrow gauge, the output from the coal-field has had to face the successful competition of the larger coal-fields of South Wales, the Forest of Dean and the Midlands, but up to the present time it has held its own.

The names of the seams, together with their thicknesses, are as follows, taking them in descending order:—

(1) Hard vein, varying in thickness from 2 feet 2 inches to 2 feet 6 inches.
(2) Stinker vein, about 6 inches thick.
(3) Top vein, varying in thickness from 12 inches up to 2 feet 4 inches.
(4) Holly Bush vein, usually about 2 feet 6 inches thick.
(5) Great vein, usually about 2 feet 6 inches thick.

The Hard vein occurs fairly uniformly over the whole of the district (Fig. 1, Plate III.), but in some areas there is evidence of a not altogether settled condition during its deposition. The coal is interspersed in places with thin layers of dirt and nodules of stone, often with a smooth surface, which indicates that during its formation it was submerged by water.

The distance between the Hard vein and the Stinker vein is about 66 feet The Stinker coal, being only some 6 inches thick, has not been worked in the basin.

The Top vein lies about 48 feet below the Stinker seam, and, being of exceptionally good quality, has been very nearly extracted. This seam at the southern end of the basin was about 2 feet 4 inches thick, and continued of uniform thickness up to about 300 feet north of the north pit of the Parkfield Company.

From that point it becomes thinner as it travels northward, eventually coming down to about 12 inches.

The distance between the Top vein and the Holly Bush vein at the southern end of the basin varies from 30 to 36 feet, and at the northern end it is about 66 feet. The Holly Bush seam in its maiden condition was spread uniformly over the basin, both as regards thickness and quality.

The Great vein is the lowest seam of workable coal yet proved in the coal-field.

Faults.—The coal-field is traversed by several faults, one of which has an upthrow to the west of about 450 feet, and separates the Coal Pit Heath colliery from the Parkfield colliery. It runs in a north-and-south direction (Fig. 2, Plate III.). There are several faults in the southern end of the basin, with displacements of from 20 to 60 feet in a westerly direction.

Methods of Working.—The Hard vein is worked by the stepped longwall system (Fig. 3, Plate III.). The main level-headings, driven on the strike of the seam, are generally about 45 feet wide, with the roadway cut in the middle. After the coal has been taken out for 6 to 9 feet forward, about 3 feet of the roof is blown down, to make the necessary height for the tubs and horses to work therein. The rubbish is stowed in the goaf. From the headings, stall-roads, turned uphill, at intervals of 100 feet, are driven for a distance of 300 feet. They are then cut off by another level-heading driven at a higher level. The stall-roads are usually 6 feet high from the top of the rail and 9 feet wide (a sufficient width for a double set of rails), and, owing to the gradient, act as self-acting inclines. A single-link chain, $\frac{1}{2}$ inch, running round a small wheel attached by a lashing chain to a post fixed at the top end of the stall-road, is generally used for lowering and raising the tubs. The advantage of using a chain in the advancing stall-roads arises from the fact that it can be lengthened by the addition of shorter pieces by the simple application of an ordinary C link.

The coal, where interspersed with bands of dirt, is very friable, and does not allow of holing very far under it, as it falls in small quantities: but, where it can be holed for a distance of 3 feet, it is found to break off the face in fairly large pieces. As a rule, no explosive is allowed to be used in the coal, exceptions being here and there a small pop-shot in the cutting rib.

When the holed coal has fallen to the floor, the workmen clean out the bands of dirt and any other foreign material. The coal is then loaded into small wooden boxes or hutches, carrying about ¾ cwt. each, and then dragged along the floor of the place by young men employed for the purpose, to the empty tub, where it is tipped over and unloaded; and this process goes on until the tub is filled.

Generally speaking, two men and one loader are employed in each stall-road, which has a working-face, 100 feet long, attached to it.

The permanent main jigs, spaced about 660 feet apart, are driven in a straight line on the full pitch of the seam. Refuge-holes are placed on one side of the jig, about 45 feet apart, and as the jig is being driven upward, wooden cogs are set, where required, for the support of the roof. When the jig has been driven the required distance, a portion of the floor is blown away at the upper end in the shape of a wedge, so as to form a flat place, upon which the landing-plate is laid down. Two posts are then fixed, one on each side of the road, and between them a wooden frame, consisting of two pieces of strong timber, called a "jig-frame," is attached to the posts by bolts. Inside the jig-frame, a jig-wheel, 2½ feet in diameter, with brake-arrangement, is fixed; and a chain (½ inch), working in the trod of the wheel, is used for lowering the full tubs and drawing up the empty ones from the higher to the lower level.

Near the top of the jig, on the level-heading, a double parting or passbye is made, for the purpose of collecting the full and empty tubs, and a similar arrangement is made at the bottom of the jig.

Horses are employed to draw the coal from the double partings to the main haulage-rope.

A double set of rails is laid in the stall-roads; and in the main jigs, three rails are laid near the top and bottom, and four rails in the middle.

The Holly Bush and Great veins are separated at the southern end of the basin by 30 to 40 feet of soft shale, and consequently have to be worked separately. The Holly Bush is worked without much difficulty; the Great vein, however, gives trouble, owing to the bad roof and the soft floor, but, as the seams come closer together both difficulties disappear.

At the northern end of the coal-field, these seams, being divided by only 18 inches of soft black shale, are worked together by what is known as the "double-stall system" (Fig. 4, Plate III.). A main level-heading, for opening out work, is driven on the strike of the seam, and at a convenient distance, a jig is driven upward, on the full pitch of the ground, for a distance of 60 feet. On both sides of the jig, stall-roads are driven as nearly as possible in the same direction as the main level-heading. When the jig has been driven a further distance of 60 feet, another pair of stall-roads is turned in the same direction as the two lower stalls; and, as both work off the coal forward, they thirl through to each other, two on the left hand and two on the right hand of the jig, and take away the coal in an open face, about 60 feet long, leaving a pillar of coal on the lower side of the lower road, and a similar pillar on the upper side of the top road. These stalls are generally driven forward for a distance of 180 feet (that is, half the distance between the main jigs), and then the pillars are taken out to within a few feet of the jig. The coal got in the stall-roads is brought on to the jig for the purpose of being lowered to the level-headings.

The coal is jigged downward in stages of 60 feet each, so that it becomes evident that not more than two or three sets of stalls can be worked off the same jig at one time, on account of the number of stops, and the hooking and unhooking of the loaded tub in its descent and of the empty tub in its ascent. The writer hoped, at one time, to obviate this difficulty of changing, by introducing a balance-carriage, but he found that the roof settled too quickly after the coal had been taken away. There was also a further difficulty that the pitch of the seam was not uniform, and became steeper as the jig advanced towards the outcrop.

Two coal-getters and one loader are usually employed in each stall-road.

The colliers employed in this seam always hole the coal in the soft parting lying between the two coal-seams. The coal works harder in these seams on the full pitch, but it is found to work the easiest and best, giving a better percentage of large coal, with the roads driven on a level course and the face about half on the pitch. The coal is loaded into the tubs as "through

and through " or as it comes off the face, and is sent to the surface as such.

At the bottom of the jigs on the level-headings, double partings or passbyes are made, as in the Hard vein, for the purpose of collecting the tubs.

The roof of the seam is shale, locally known as "dunns," and on account of there not being sufficient rubbish to stow the working-places, it not infrequently happens that large wooden cogs, about 6 feet square, are erected to support the roof, but when the roof starts to weight, it comes down and generally in very large blocks.

The roof in the main level-heading and in the jigs is ripped down until the head roadways are raised to the top of the coal-seam and well into the roof; they then stand fairly well without heavy repairs.

The working-day consists of 8 hours. The men begin to go down the pit at 6 a.m. and finish work at 2 p.m., but it frequently happens, by mutual arrangement, that they work 10 hours per day, for which they are paid at the rate of 1¼ days. On Saturdays, they finish work at 1 p.m.

Tubs.—There is no uniform tub in the coal-field: at one colliery, they are made of steel plates, with a carrying capacity of about 8 cwts.; whilst at the adjoining colliery they are made of wood, with a capacity of 10 to 12 cwts. Bridge-rails are usually laid on wooden sleepers for the tramways in the stall-roads or where they are drawn by horses, but where engine-power is employed they run on single T rails.

Haulage.—The system of haulage most largely adopted is the main-and-tail rope, generally driven by a horizontal high-pressure engine, geared with two drums and a clutch-arrangement for putting the drums in and out of work. In another system, a single rope is attached to the back end of a number of coupled trams: then, taking advantage of the dip of the seam, the weight of the tubs is sufficient to drag the rope down the incline, and a steam-engine, placed at the top, is employed to draw the rope and the loaded tubs up again.

Screens.—The coal, on reaching the surface, after being weighed, is tipped into an ordinary fixed bar-screen, the bars, about 10 feet long, being usually spaced about 1⅛ inches apart.

The small coal falls through the bars into a truck placed underneath; and the large coal passes along and over the movable door at the bottom-end of the screen, and falls into the large-coal truck. Consequently, only two sorts of coal are made for the market. When the coal is filled as "through and through" or as it comes out of the pit, steel plates are used for covering the bars of the screen. No attempt, so far as the writer knows, has been made to size the coal by picking belts or jigging screens in this coal-field.

Water.—There are three large pumping-engines at work in the coal-field, of the Cornish beam condensing type, running about 6 strokes per minute each in the winter, and probably about 3 strokes per minute in the summer, raising when working at full speed about 1,000 to 2,000 gallons per minute. At two of the collieries, the mine-water is partly used for feeding the boilers, and at another colliery, the surface-water is caught, and stored in large reservoirs.

Boilers.—Most of the boilers, at present in use, are of the Lancashire type. The working pressure is about 60 pounds per square inch, but recently two boilers have been put down, capable of carrying a pressure of 100 pounds per square inch.

Mr. T. H. Bailey remarked that the Bristol coal-field comprized one of the most interesting coal-formations in this country. The upheaval of the Coal-measures was a remarkable feature: the coal-seams being inclined at high angles and unevenly distributed. In the Ashton series, for example, one of the seams was at places only a few inches thick, while at others it was increased to as much as 10 feet in thickness. The coal was very friable, yielding only 30 per cent. of large coal, with 70 per cent. of small coal, and occasionally as much as 80 per cent.

Mr. J. T. Onions pointed out that his paper dealt chiefly with the northern or Parkfield series, which gave 50 per cent. of large coal. An attempt had been made to prove the Mangotsfield series—which was supposed to lie beneath the Parkfield series—by a drift, but without success, and possibly, even if discovered, the seams could not be profitably worked.

The further discussion was adjourned.

THE SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS.

ANNUAL GENERAL MEETING,

HELD AT THE UNIVERSITY, BIRMINGHAM, OCTOBER 17TH, 1904.

MR. ISAAC MEACHEM, JUN., RETIRING-PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting and of Council Meetings were read and confirmed.

The following gentleman was elected:—

ASSOCIATE MEMBER—

Mr. THOMAS MELLOR MASSEY, 19, Slaney Road, Walsall.

The Annual Report of the Council and the Treasurer's Accounts were read as follows:—

ANNUAL REPORT OF COUNCIL, 1903-1904.

The membership has increased by 13 during the past year, so that there are now 192 members upon the books.

The expenditure of the year has been lower, but unfortunately the receipts have also been less, and as a consequence the balance in the bank has been reduced by £13 5s. 7d., and now stands at £195 18s. This reduction arises from many members neglecting to pay their subscriptions. There is also considerable difficulty in collecting the subscriptions, owing to so many of those in arrears being resident abroad, and to constant changes of address. The matter is, however, now so serious, the arrears amounting to £270 12s. that the Council will, with regret, have to strike several members off the list, unless the subscriptions are paid forthwith.

There have been five General Meetings and six Council Meetings, and the papers read at the former consist of the

"Presidential Address" of Mr. I. Meachem, Jun.; "Gold-mining in Southern Rhodesia" by Mr. Thomas Warth; "Notes on Early Mining in Staffordshire and Worcestershire" by Mr. J. H. Jackson; "Coal-cutting Machinery of the Percussive Type" by Dr. A. Simon; and "The Northern Portion of the Bristol Coal-field" by Mr. J. T. Onions. Several of these papers evoked interesting discussions.

It was intimated in last year's report that The Institution of Mining Engineers, with which the Institute is associated, would hold their annual meeting in Birmingham in September last, and although it did not come immediately within the year under review, yet as it is past, the Council have pleasure in announcing that the meeting was very successful in every way, so that the President of the Institution pronounced it "the best in all respects that he had attended." The presence of 70 members of the Association des Ingénieurs sortis de l'École de Liége added to the importance and interest of the meetings, and a joint letter from their President and Secretary has been received, in which they say: "Returning to Belgium after a tour in a friendly country, where we received so charming a welcome, we sincerely wish to thank you for your great kindness in arranging our stay in Birmingham. We believe we are expressing the sentiments of all our members when we assure you that they will keep an unforgetable remembrance of that portion of the excursion, and that they will often think of the agreeable and instructive days passed in the great industrial city of England."

Your best thanks are due and are hereby tendered to the various firms who opened their works, and in other ways assisted in entertaining the visitors, and to the Birmingham University authorities for the use of rooms.

The membership of The Institution of Mining Engineers has increased to 2,704; and the Manchester Geological and Mining Society join as from August 1st, 1904, so that there will be a considerable accession of members, and the inclusion of their papers with the many read at the six other societies will materially add to the value of the *Transactions*.

Dr. THE TREASURER IN ACCOUNT WITH THE SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS, FOR THE YEAR ENDING JULY 31ST, 1904. **Cr.**

	£	s.	d.		£	s.	d.
To balance in bank	209	3	7	By The Institution of Mining Engineers	101	0	8
„ subscriptions received	161	13	0	„ rent of Institute-room	20	0	0
„ bank-interest	3	9	3	„ salaries of secretary and reporter	50	0	0
„ balance from The Institution of Mining Engineers' Meeting Expenses Fund	2	10	0	„ expenses of audit	1	2	6
				„ printing and stationery	4	1	6
				„ postages, telegrams, etc.	4	13	2
				„ balance in bank	195	18	0
	£376	15	10		£376	15	10

BALANCE-SHEET, 1903-1904.

Liabilities.	£	s.	d.	Assets.	£	s.	d.
The Institution of Mining Engineers	23	4	9	By subscriptions due	270	12	0
To balance	443	5	3	„ balance in bank	195	18	0
	£466	10	0		£466	10	0

Examined and found correct,

DANIEL ROGERS.
WILLIAM H. WHITEHOUSE.

October 17th, 1904.

This balance is exclusive of considerably more than £100 worth of property, for which no credit is taken.

The Annual Report of the Council and the Treasurer's Account and Balance Sheet for the past year were adopted.

ELECTION OF OFFICERS, 1904-1905.

The SCRUTINEERS reported that the following gentlemen had been elected:—

PRESIDENT: Prof. R. A. S. REDMAYNE.

VICE-PRESIDENT: Mr. W. N. ATKINSON.

NEW MEMBERS OF COUNCIL:

Mr. T. H. BAILEY.	Mr. H. W. HUGHES.
Mr. F. A. GRAYSTON.	Mr. H. R. MAKEPEACE.

The PRESIDENT (Prof. R. A. S. Redmayne) proposed a hearty vote of thanks to the retiring president and officers for the past year.

Mr. H. C. PEAKE, in seconding the motion, observed that, on account of the Annual Meeting of The Institution of Mining Engineers having been held in Birmingham during their year of office, their work had been unusually onerous. He noticed that the Report of the Council contained a letter of thanks from the Belgian Association who joined in the meeting. He had had the opportunity of perusing that letter, and noticed that Mr. Alexander Smith had omitted a part of that letter which expressed their gratitude to him personally. He desired to couple the name of Mr. Alexander Smith, their Secretary, in this motion for the excellent manner in which he had conducted the arrangements.

Mr. ISAAC MEACHEM, replying to the vote of thanks, said that the office had not entailed much hard work. He begged to thank the members on behalf of the retiring officers and for himself for the vote of thanks accorded them.

The PRESIDENT (Prof. R. A. S. Redmayne) delivered the following address:—

PRESIDENTIAL ADDRESS.

By R. A. S. REDMAYNE.

Before entering upon the task appointed to me to-day, a task, be it said, so difficult of accomplishment on the part of its author, and I fear of very doubtful acceptance when accomplished, permit me the pleasure of thanking you for the very great honour which you have conferred upon me, in having elected me to fill the presidential chair of this Institute for the ensuing year, a chair which has been occupied with such grace and distinction by able predecessors, whose good example, though incapable of emulating, I shall do my utmost to follow.

I think I am correct in stating that the South Staffordshire and East Worcestershire Institute of Mining Engineers has been in existence for 37 years, and numbers at the present time 148 Members, 5 Associate Members, 5 Associates and 34 Students. Although this statement shows a somewhat better position in this respect than that of a year or two back, it is far below what it should be and has been, for I find that in 1882 there was a total of 246 members. In fact, as compared with the other federated and non-federated mining institutes, it should be, with the exception of The North of England Institute of Mining and Mechanical Engineers and the South Wales Institute of Engineers, unrivalled not alone in point of members, but also as to financial status and the number and character of the papers read and discussed at its meetings—such is our geographical position in relation to the mining areas of the Midland counties, and such is the extent and character of the coal-fields, and, may I add, such are the human resources from which we can or should draw. Now, how can we exalt the Institute to the great and commanding position which by right of locality and circumstance it should occupy in the mining world? As to the character of the papers and discussions, they compare favourably with those of any other mining societies, but the papers, however, might be more numerous and the meetings more fully attended; the finances are merely the measure of the number

of members, and the number of members is dependent on the individual exertions of each one of us—on our desire to promote the usefulness and well-being of the Institute.

The number of gentlemen directly or indirectly interested in mining in the counties of Stafford, Worcester, Warwick and Shropshire, who are not members of this or any other mining institute, must be very considerable. Now if each member would essay to induce some of them to attach themselves to our Institute, and to prove to others of them the value of membership by our individual earnestness in attending meetings, contributing to the reading and discussion of papers, and otherwise assisting in a spirited and ardent prosecution of the work of the Institute, I, for one, do not doubt that our efforts would be crowned with success, and that the Institute would occupy that sphere of increased influence for good in the mining world which I am sure we all so desire that it should take.

Another matter has occurred to me, and one in close connection with the subject just alluded to, which is this: Are we as an individual Institute, and the other branches of The Institution of Mining Engineers, benefited by the federation? Permit a child for a moment to consider his position in relation to his guardian! In point of number of members and financial status, The Institution of Mining Engineers has without doubt steadily improved since its inception in July, 1889, though the improvement in this respect may possibly be attributable to the natural increment due to time and the extension of the mining industry, but doubtless also in no small degree to the fact that the combined societies are now generally known and regarded as The Institution of Mining Engineers, a title which presents to many outside the Institution an alluring inducement towards membership, for the title of M.Inst.M.E. does undoubtedly confer a certain amount of distinction and reputation on its owner, especially in the minds of those unacquainted with the ease with which it is acquired and unaware of the fact that it does not necessarily imply any particular merit.

Of course, the original object of all these Institutes, and that which led to their formation, was the congregating of mining engineers to discuss coal-mining affairs and practices of peculiar importance to the locality in which the Institute was situated,

and secondly of mining engineering topics in general; but The Institution of Mining Engineers has in a large measure altered, or, at any rate, modified this, and the individual Institutes no longer possess in their old degree "a local habitation and a name." I mean that, to some extent, their old individuality has been lost, and not that their sphere of influence has been narrowed or destroyed. Combination and extension are the order of the day, and it would almost appear that in the case of The Institution of Mining Engineers, the latter is as applicable to this as it is to other "combines." At present The Institution of Mining Engineers occupies a peculiar position, for in destroying in some measure the individuality of what are now its subdivisions, it has done so without, so far, acquiring much of its own.

If the combining societies are to fulfil their mission of usefulness in the mining world, one only of two courses is open to the Institution, namely:—(1) Either to dissolve into its original components, when by a process of natural selection the fittest will survive and expand, or (2) to proceed still further along the line of evolution so far followed and still further to extend its constitution and become The Institution of Mining Engineers in meaning as well as in word. If the title of M.Inst.M.E. is to be regarded throughout the mining world as a designation of real importance, of weight and of honour, we must heighten the standard of admittance and put the Institution on a footing equal in all respects with that of the Institution of Civil Engineers. What I now say may be regarded possibly as contradictory of my remarks anent the improvement of our own Institute, at the opening of my address, but a little thought will show that that is not so: the two cases being quite different. The status of the mining engineer in the eyes of the public is below that of the civil engineer, for membership of the Institution of Civil Engineers has come to be regarded of late years (since the policy I now hint at as being desirable in our own case was carried into effect) as bringing with it, and rightly so, considerable credit and repute. The designation M.Inst.M.E. might be made á safeguard for the public; for, as matters are, its appearance behind the name of some unscrupulous person in a mining prospectus or report brings discredit on those who so justly desire that the status of mining engineers should stand above reproach and be equal in distinction to that of any other body of applied scientists.

Further, and this is the last question in our domestic policy, if I may use the term, to which I shall allude to-day, could not some *modus vivendi* be arrived at as between The Institution of Mining Engineers and the Institution of Mining and Metallurgy, either in the way of amalgamation or of definition of spheres of operation? The latter society is doing extremely good work, its meetings are well attended, the papers, especially of late, are of an increasingly high standard, and the discussions animated and productive of good. It seems a waste of energy for these two societies to be working on more or less the same lines, and yet to remain distinct.

Passing now to matters of more technical import, the question of greatest consequence confronting us in this part of the Midlands is undoubtedly the problem of deep mining, and particularly that of the profitable working of a thick seam lying at a great depth from the surface. The last few years have seen the inauguration of the development of the mining tracts lying beyond the eastern and western boundary faults of the South Staffordshire coal-field; and the near future will undoubtedly witness a still further advance in these directions from the more or less exhausted areas of the exposed coal-field. Deeper mining will, before long, also be carried out in North Staffordshire.

The subject of deep mining is a fascinating one to the mining engineer, and one which might well occupy the whole of my address to-day, but it would not be exhausted by a library of books nor in a year's discussion, and I cannot now do more than merely touch the fringe of the subject, trusting that any remarks which I may make will not be deemed out of place in view of the fact that the Royal Coal Commission has not as yet issued its final report.

The part of the problem relating to mechanical appliances does not, I think, present any insuperable obstacles. For the difficulties in the way of winding from great depths, at least in so far as concerns depths down to 5,000 feet, have been satisfactorily solved, without resorting to the use of tapered ropes or stage-winding. The Whiting system of hoist seems to meet requirements down to this depth at the Red Jacket (vertical) shaft at the Calumet and Hecla mine in Michigan, United States of

America; and I am of the same opinion as Mr. Hennen Jennings that, with the adoption of the tail-rope in connection with this system, its usefulness would be much increased. Nor do I think that we need be greatly concerned as to the difficulties in the way of the cheap and effective transmission of power to great depths or great distances underground. For, though in fiery coal-seams it may be most dangerous, and injudicious at any rate, to use electrically-actuated coal-cutters, there should be no objection to using air compressed by electric motors stationed some considerable distance along the main intake air-ways and conducting the compressed air to the face. Secondary haulage could be similarly worked.

When electricity first came to be applied to mining as a motive force, it was thought that the days of compressed air were over, but the fact was that the air had neither been compressed nor used to the best advantage. Indeed, I remember an efficiency of 25 per cent. being regarded as a high result. In reality, compressed air is of great advantage as a long-distance transmitter of power. For nowadays, what with compound steam-engines, isothermal compression (performing the work in separate cylinders with intermediate coolers: two or more stage-compression), mechanical improvements such as the use of lever-lifted valves (of the Riedler type) instead of air-moved flaps (and so avoiding wire-drawing), and adiabatic use or reheating of the air (by electric or stove reheaters), very remarkable efficiency-results have been obtained. For instance, the Compressed Air Company in Paris deliver about 8,000 horsepower from two central stations through 35 miles of pipes, the furthest motor being 4½ miles away. In 1889, they were supplying their customers for one indicated horsepower at the central engine, with 0·39 indicated horsepower with cold air and 0·47 indicated horse-power with reheated air just before entering the customer's motor; it was shown in 1891 that with stage-compression and other improvements, still higher efficiencies might be obtained, namely, with cold air, 0·46; with hot air, 0·65; and if the hot air was sprayed with water, 0·80; and these results have since in great measure been attained. The beneficial results in the way of ventilation and the cooling to some extent of the mine-atmosphere at the face by the extensive use of coal-cutters actuated by compressed air, have only to be mentioned to be appreciated.

Perhaps the most difficult part of the problem of deep mining that we shall have to solve, is that which relates to heat-increment and ventilation, and that which is peculiar to coal-mining: the crush due to the pressure of the superincumbent strata. These are the main factors in the causes limiting the depth at which it will pay to mine. In respect to the question of temperature, though no very definite practical conclusions can be said to have been arrived at, the best and fullest information yet to hand is undoubtedly that contained within the pages of the minutes of evidence of the first and second reports of the Royal Coal Commission at present sitting; but, based on such data as we do so far possess, I do not think any formula for determining the heat at any depth can be of any practical value. For instance, we find that at Pendleton colliery, in Lancashire, the increase in the temperature of the air was only 28·5° Fahr. in a depth of 3,483 feet, that is to say, a gradient of 1° Fahr. for every 122 feet; whereas Prof. J. S. Dixon stated that at the deep boring at Schladebach, the temperature at a depth of 5,630 feet was 133·9° Fahr., and taking as the starting-point a temperature of 51·8° (the temperature at a depth of 118 feet), this gives an increment of 1° Fahr. for every 67·1 feet. The first instance is, however, much the more valuable, as tending to show the probable temperature of the air under actual working conditions. I do not think that we can take the data obtained from bore-holes as helping us much in this direction. For, taking another instance, in the case of the Bezuidenville bore-hole on the Rand, the rise in temperature worked out at 1° Fahr. for every 208 feet in depth over a depth of 3,251 feet. Mr. Hennen Jennings states that the Turf Club Syndicate began two bore-holes before the war, and have completed them since the war. The west bore-hole cut through the Reef series at a depth of 4,743 feet and the east bore-hole at 4,825 feet. Experiments as to the heat-gradient have been made in the west bore-hole, though not to the full depth, and definite and conclusive results have not yet been obtained, but are not expected to be materially different from the results arrived at in the Bezuidenville bore-hole.

In 1895, at the Calumet and Hecla copper-mine in Michigan, United States of America, the increase was 1° Fahr. for every 223 feet calculated over a depth of 4,580 feet, at which the temperature was only 72° Fahr. When I visited this mine in

1902, the temperature in the Red Jacket vertical shaft at a depth of 4,900 feet was said to be 87·6° Fahr. It would be interesting to learn what was the temperature of the air at the bottom of the No. 3 shaft of the Tamarack copper-mine adjoining, as this is now the deepest vertical shaft in the world, being over 5,000 feet in depth. Much has been made of the air-temperatures in the Simplon tunnel; but, as affording data for guidance in the matter of temperature-gradients in coal-mining in this country, they are of little use, in view of the fact that quite recently a spring of water of 700 to 800 gallons per minute, of a temperature of 113° Fahr., has been encountered in the tunnel. Nor has any very great or definite result been the outcome, as yet, of the work of the Underground Temperature Committee of the British Association, which since its appointment in 1867 has issued no less than 22 reports. I, for one, welcome the suggestion put forward by Mr. W. E. Garforth that the subject should be further investigated by a committee of mining engineers carrying out temperature-observations in exactly the same manner all over the country; but I would further suggest that there be represented on such a committee one or more well-known geologists, as the question is in close relation to lithological and other geological conditions, and that the committee should work in line with similarly constituted committees on the Continent and in the Colonies.

The only points upon which we are certain in respect to heat-gradients would appear to be that (1) the local length of the geothermic degree is quite undecided; (2) this length is different in different districts; (3) isogeotherms are not parallel down to a depth of 5,000 feet; and (4) I do not think we need apprehend any difficulty due to heat-increment in working down to a depth of 4,000 feet that cannot be overcome by sinking large shafts and causing large volumes of air to circulate through the workings, and by perhaps some modifications in our present modes of ventilation. Undoubtedly, some system of local or secondary ventilation will have to be resorted to, some arrangement whereby numerous splits of cool fresh air shall be taken off one or more intakes and circulated round only a circumscribed area of workings before being drawn to the surface. As emphasizing this view, take, for instance, the case quoted by Mr. G. A. Mitcheson at Florence colliery, in North Staffordshire.

Though they have there face-temperatures as high as 82·5° Fahr., some places are as cool as 73° Fahr., owing to the fact that there is a greater current of air traversing a limited length of face, in the instance in mind about 3,000 feet. Helping-up fans, driven either electrically or by compressed air, might also with advantage be placed in the return-airways near the face to give velocity to an otherwise sluggish air-current, or to draw artificially-cooled air through pipes and distribute the same at the face. Some such devices as these may, I have no doubt, be satisfactorily worked out and adapted to the needs of deep mining. It should not, at any rate, be difficult to increase greatly the velocity of the ventilating current in the main intakes, this being chiefly a question of mechanical power.

We have seen that practically no difficulty of moment is being experienced in the working of the great copper-bearing conglomerate of the Lake Superior region at a depth of about 5,000 feet from the surface, and that, with an increase of temperature of 1° Fahr. in 200 feet, there is no reason why the temperature or pressure should with a formation of solid sandstone debar mining from being carried on in the Rand to a depth of at least 6,000 feet. But, although these instances go far to prove that mining can be carried on at great depths in metalliferous mines, they do not help towards a solution of the problem facing us in this part of the world, namely, how to exploit profitably a thick seam of coal lying at a great depth from the surface: for the question of crush is of little account in the former case.

The effect of pressure or tension, whichever it is, seems to be much more evident in the case of a thick than a thin seam. Thus at Florence colliery, North Staffordshire, where the depth from the surface to the deepest working seam is 2,577 feet, and the thickness of the seam but 5 feet 6 inches, the effect of the pressure, though more than noticeable, cannot be said to be great; whereas at Hamstead colliery, South Staffordshire, where the Thick coal-seam lies at a depth of only 1,845 feet and is 24 feet thick, the effect is very marked, indeed, more so, perhaps, than in any other known instance. Of course, the proximity of faults may in some measure account for this, but it would almost seem as if the coal itself existed here in a state of considerable inherent tension, which would explain those sudden accessions of "creep" termed "bumps," which

prove so troublesome in the working of this seam at this colliery, breaking up the roads and smashing the timber. Bad as these are, they are not, perhaps, the worst results of pressure (tension is but the secondary effect of pressure), for, according to Mr. Isaac Meachem, the percentage of slack in working coal at a depth of 2,100 feet in South Staffordshire is no less than 65, as compared with 50 at a depth of 300 feet; and he estimates that at Hamstead colliery (1,845 feet) they lost 38 per cent. (inasmuch as they had to leave it unworked) of the coal as compared with a 10 per cent. loss at 300 feet. It has occurred to me that a partial prevention of these evils might be secured by the entire removal of some thin seams lying below the Thick coal-seam (say in the case of Hamstead colliery, the Heathen coal-seam lying 24 feet below the Thick coal-seam) working this out by longwall, and packing the workings with stone before attacking the Thick seam, maintaining the main roads in the lower and worked-out seam; or, if such lower seam be one that is subject to gob-fires, possibly the best plan would be to drive the main roads in some bed of fire-clay or bind, in close proximity to the Thick coal, to the boundary, and work the Thick coal homewards. I am inclined to think that the latter suggestion has been actually tried. The capital necessary in both cases would be great, and the period that would elapse before securing any large return would be long, but the ultimate result would surely be more satisfactory. On these points, however, mining engineers, who have had life-long experience in working the Thick coal of South Staffordshire, are far better fitted to advise me than I them.

But I must not put any further strain upon your patience and good nature; enough has been said, I think, to show that our profession is not the least important branch of engineering. Indeed, I know of no calling, unless it be that of a medical practitioner, that makes so many and great demands upon one's intelligence, physical endurance, and moral strength, as that of the mining engineer; for, besides being an all-round miner, he has to have more than an elementary acquaintance with the allied sciences, and their applications; being in daily contact with large bodies of workmen, he has to learn to feel for, while working with, them; indeed, he has to be possessed, in no small degree, of that quality, which we name tactfulness; and few men have to be more resourceful in dangerous emergencies.

Great Britain has been for many years the cradle of great mining engineers, and time was when others used to come to learn of us; but times are changing, we live in days of advancement, and we must move with the times, or be left behind. Let us not be above learning when necessary from our friendly opponents. Let us learn to take a wide view of things, and not be content to follow in the old beaten track of this or that mining district. In mining, as in all else, there is need at all times "to think imperially."

Mr. ARTHUR SOPWITH proposed a hearty vote of thanks to Prof. Redmayne for his able and interesting address. He regretted that it was not usual to discuss an address of this nature, as there were points raised well worth discussion. He thought that the members could best show their appreciation by following his advice, given in the early part of the address, regarding their Institute. He asked all members to put their shoulders to the wheel, and endeavour to revive interest in the Institute, besides doing all they could to attend the meetings and inducing other mining engineers to join.

Mr. H. W. HUGHES, in seconding the motion, remarked that he had listened with much interest to the President's concise and able address. He was particularly interested in that part which dealt with the problems of deep mining. He, for his part, had no fear as to the ultimate result. Difficulties had often arisen, but mining engineers had solved them. What they really feared was trouble in ventilation, and those due to the excessive weight of the strata. These difficulties he experienced at a colliery working a thick seam 2,200 feet below the surface.

Mr. ISAAC MEACHEM stated that the question of working the thin seams, as suggested by the president, had been considered in the early days of the Hamstead collieries by his father, brother and himself; but, owing to the excessive expense, it was impossible to carry it out.

The PRESIDENT (Prof. R. A. S. Redmayne), in acknowledging the vote of thanks, said that if the members thought it desirable to discuss his address, he would be happy to waive the usual custom and to take part in the discussion.

NORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

EXCURSION MEETING,
HELD AT MANCHESTER, JULY 18TH, 1904.

The members visited the works of the British Westinghouse Electric and Manufacturing Company, Limited, at Trafford Park, Manchester.

TRAFFORD PARK WORKS OF THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED.

The British Westinghouse Company acquired about 150 acres of land at Trafford Park; 55 acres of this are enclosed within the buildings, while 32 acres are roofed in. There are altogether nine buildings, including the offices. The machine-shop, 1,000 feet long by 430 feet in width, is divided into five bays; next to this is the steel-foundry; beyond which is the brass and malleable-iron foundry, with pattern-shop and stores. There is a box-factory on the right of the machine-shop. A noticeable feature of the works is the excellent lighting and ventilation.

The principal machine-shop is divided into five bays, and the whole structure is of steel. The largest lathe will take in work 125 inches in diameter, while the length between the centres is 45 feet. There are 10 feet to 28 feet boring-mills, 10 feet to 14 feet planing-machines, large radial drills, a three-spindle vertical milling-machine and double-headed two-spindle horizontal boring-machines.

In the steel-foundry, there are 20 tons open-hearth Wellman-Seaver rolling-furnaces of the most recent design; two 50 tons and one 10 tons overhead electric travellers; five air-hoists and jib-cranes; cutting-saw; annealing and drying ovens; and other usual appliances. The laboratory-arrangements are complete, chemical and mechanical tests being carried out in the usual way. There is a 100,000 pounds testing-machine.

The iron-foundry is of the same size as the steel-foundry. There are two Whiting cupolas, with special weighing machinery, by which the proper mixture of pig is obtained. The cupola-blast is generated by two Sturtevant blowers, driven by an induction-motor. Iron-castings, up to 30 tons in weight, are made.

In the boiler-house, there are six Babcock and Wilcox boilers, each having 4,020 square feet of heating-surface, steam being generated at a pressure of 160 pounds per square inch. These boilers are mechanically fired by Roney stokers, driven by a Westinghouse steam-engine. There are three air-compressors of great capacity.

The tunnel under the machine-shop is extended to the foundries and pattern-shop.

Electrically-driven cranes are used throughout the works; and electricity is the chief motive power. In the large machine-shop, there are four 50 tons cranes, seven 10 tons cranes, and five 5 tons cranes. There are two 20 tons cranes in the transformer department. In each of the main aisles of the steel- and iron-foundries are two 50 tons cranes and four 10 tons cranes.

ORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

EXCURSION MEETING,
HELD AT HEDNESFORD, AUGUST 22ND, 1904.

The members visited the works of the Cannock and Rugeley olliery Company, Limited, at Hednesford.

CANNOCK AND RUGELEY COLLIERIES.

THE WIMBLEBURY MINE.

The shaft is 990 feet deep and 15 feet in diameter. The iron headgear is 56 feet high, and the pulleys are 14 feet in diameter. The winding-engine, with two cylinders 32 inches in diameter by 5 feet stroke, has a drum 15 feet in diameter. The cages carry four tubs, and the average weight of coal lifted is about 12 cwts. per tub. The hauling-engine, with two cylinders 18 inches in diameter by 4 feet stroke, works an endless rope and an air-compressor cylinder. The coals from two districts are delivered to the endless-rope haulage by a self-acting incline 1,950 feet long, and the coal is brought out of other districts by main-and-tail ropes.

A Chandler fan, 10 feet in diameter by 5 feet in width, produces 51,000 cubic feet per minute at 1·10 inches water-gauge, when running at 120 revolutions per minute. It is driven by an engine with a cylinder 13 inches in diameter by 26 inches stroke.

CANNOCK WOOD MINE.

The shallow shaft is 534 feet deep by 12 feet in diameter. The winding-engine, with two cylinders 24 inches in diameter by 4 feet stroke, has a steam-reverser and steam-brake. The drum is of the parallel type, 11 feet in diameter, and the cages carry three tubs. The north-east district, 5,100 feet long, is

worked by an endless rope from engines fixed on the surface. The south-east district, 5,700 feet long, is worked by main-and-tail ropes from engines fixed on the surface.

In the Six-feet seam most of the coal is got by disc coal-cutters, run by motors, and cutting 5¼ to 5½ feet under. The average length cut during a shift of 8 hours is 180 to 200 feet.

The deep shaft is 600 feet deep and 12 feet in diameter. The winding-engine, with two cylinders 26 inches in diameter by 5 feet stroke, has a drum 12 feet in diameter, and a steam-reverser. The cages take three tubs at a time. The haulage in the north district (7,500 feet) and in the south-east district (4,500 feet) is performed by an endless rope driven by an engine, with two cylinders 18 inches in diameter by 3 feet stroke. In the south-east district the coals are delivered to the main endless rope by a secondary endless rope, which is motor-driven. Three compressed-air hauling-engines are used for secondary haulage. The north-east district (6,300 feet) and the Rawnsley and north-west districts (4,500 feet) are installed with main-and-tail rope haulage worked by engines fixed on the surface.

There are 13 Lancashire boilers (30 feet by 8 feet) and one Lancashire boiler (30 feet by 9 feet), each working at a pressure of 100 pounds per square inch; air-compressors; a water-softener and cleaner, capable of treating 16,000 gallons per hour; a water-heater; and a vertical water-heater.

NORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,

HELD AT THE NORTH STAFFORD HOTEL, STOKE-UPON-TRENT, SEPTEMBER 19TH, 1904.

MR. A. M. HENSHAW, PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting were read and confirmed.

The following gentlemen, having been previously nominated, were elected:—

ASSOCIATES—

Mr. RICHARD FISHER, 56, Hamilton Road, Birches Head, Hanley.

Mr. GEORGE GOODWIN, 71, Hammersley Street, Birches Head, Hanley.

STUDENT—

Mr. R. C. MACGOWAN, Ash House, Talke.

The officers for the ensuing year were nominated.

NORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

ANNUAL GENERAL MEETING,

HELD AT THE NORTH STAFFORD HOTEL, STOKE-UPON-TRENT, OCTOBER 10TH, 1904.

MR. A. M. HENSHAW, RETIRING-PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting were read and confirmed.

The following gentlemen, having been previously nominated, were elected:—

MEMBERS—

Mr. H. J. BLACKHAM, Stanier Street, Fenton.
Mr. SAMUEL DANKS, The Silverdale Company, Limited.
Mr. J. T. NEWTON, Dover Collieries, Dover.
Mr. W. F. NORTJE, P.O. Box 662, Johannesburg.
Mr. H. T. PACKARD, Athenæum Club, Johannesburg.
Mr. A. TENNANT, General Mining and Finance Corporation, Johannesburg.
Mr. H. M. WALKER, Knypersley, Congleton.

ASSOCIATE—

Mr. F. FULLER, Oldcott Green, Goldenhill.

STUDENT—

Mr. J. R. DEANE, Norton Green, Smallthorne.

The Annual Report of the Council was read as follows:—

ANNUAL REPORT OF THE COUNCIL, 1903-1904.

The Council have to report that the names of 24 gentlemen have been submitted for election during the year. Of these, 4 not having paid their subscriptions, their election is void, and 4 being transfers, the net result is that 16 new names are on the books. During the year, there have been 12 resignations and 4 deaths, leaving 262 names on the register, the same number as last year.

The following table shows the membership during the past 9 years:—

Year ending.	Life Members.	Honorary Members.	Members.	Associate Members.	Associates	Students.	Totals
July 31st, 1896.	1	6	120	3	37	16	183
,, 1897.	1	6	116	5	36	19	183
,, 1898.	1	5	112	4	46	14	182
,, 1899.	1	5	106	5	43	13	173
,, 1900.	1	6	108	4	44	12	175
,, 1901.	0	6	130	9	53	22	220
,, 1902.	0	7	140	10	67	27	251
,, 1903.	0	7	145	11	73	26	262
,, 1904.	0	9	145	12	70	26	262

During the year, general meetings were held in October, January, March and May, and excursion meetings in December and July at Crewe and Manchester respectively.

The following papers were read during the year:—

"The Occurrence, Mode of Working and Treatment of the Ironstones found in the North Staffordshire Coal-field." By Mr. John Cadman.

"Presidential Address." By Mr. A. M. Henshaw.

"Fires in Mines, with Particular Reference to Seams in the North Staffordshire Coal-field." By Mr. G. E. Lawton.

"Record of the Failure of a Locked-coil Winding-rope." By Mr. W. Lockett.

"Notes on the Classification of Blackband and Clayband Ironstones." By Mr. E. P. Turner.

"Native Methods of Smelting and Manufacturing Iron in Jabalpur, Central Provinces, India." By Mr. F. H. Wynne.

These papers, together with discussions upon others, have proved both useful and interesting to the members generally.

During the past year, the usual exchanges have been received, and in addition an exchange has been arranged for the reports of the Geological Survey of Maryland. The thanks of the members are due to the following members for gifts of reports and papers, namely:—Messrs. W. N. Atkinson, Billington and Newton, A. Hassam, James Lockett and H. R. Makepeace.

The work of the Mining Classes during the last session has been very satisfactory in all subjects. The distribution of prizes to successful students took place on December 12th, 1903, the President of the Institute (Mr. A. M. Henshaw) making the presentation, and at the same time giving an address of value.

not only to students but to members of the profession. The examination at the end of the session was taken by the largest number of students recorded since its initiation.

During the year, meetings have been held at the North Stafford Hotel as in former years, as this was considered more convenient and likely to increase the attendance of members at the meetings.

The Library has been removed to 43, Glebe Street, Stoke-upon-Trent, where two rooms are jointly occupied by ourselves and the North Staffordshire Field Club, the libraries of both being available to the members of the two bodies. The Council regret that, owing to pressure of work, Mr. J. T. Stobbs has been obliged to resign the post of Librarian, and wish to record their high appreciation of the time and work devoted by Mr. Stobbs to the Library and to the interests of the Institute generally.

The Council are glad to report that the scheme for providing a college for North Staffordshire is in a more hopeful position than when they reported last year. It has been decided by the Council for the Extension of Higher Education in North Staffordshire that the college should be built by departments, as funds become available, and a strong endeavour is being made to raise the money required for the departments of Mining, Pottery and the Training of Teachers. The Institute has undertaken the collection of subscriptions for the Mining Department, for which purpose £2,500 is required, in addition to the sum of about £1,500 already paid or promised. A circular soliciting further contributions to the Institute fund, together with a pamphlet setting forth the present position of the scheme, has been issued to members of the Institute and to colliery-owners, royalty-owners, and others interested in the mineral-industries of the district. Our new president, Mr. A. H. Heath, has taken a lively interest in the college-scheme from its inception and the Council hope that sufficient funds for the building of the Mining Department may be raised during his presidency.

The report was adopted on the motion of Mr. W. N. Atkinson, seconded by Mr. A. Hassam.

The TREASURER (Mr. Thomas Ashworth) read the Annual Report of the Finance Committee, as follows:—

ANNUAL REPORT OF THE FINANCE COMMITTEE.

The Finance Committee herewith submit their statement of accounts for the year ending July 31st, 1904.

The total receipts amounted to £363 16s. 7d., of which £264 13s. is for current-year subscriptions, leaving £172 13s. 6d. unpaid to July 31st. Of the balance of arrears left over from last year's account, £63 11s. 6d. has been paid, leaving £105 5s. 6d. unpaid, making a total of £277 19s. of arrears outstanding. The serious amount of subscriptions outstanding has led the Council to place the matter in the hands of Mr. W. H. Earl, accountant, for collection, and it is hoped that this very large sum may be materially reduced.

The sale of *Fossil Charts* has yielded £18 11s. 4d. and the sale of *Transactions* £9 8s. 9d.

The result of the year's working has been to increase the credit-balance from £75 19s. 11d. at the end of the previous year to one of £101 0s. 7d. at the end of July, 1904.

The Report was adopted on the motion of Mr. G. A. MILLWARD, seconded by Mr. G. P. HYSLOP.

ELECTION OF OFFICERS, 1904-1905.

The SCRUTINEERS reported the following appointments:—

PRESIDENT:
Mr. A. H. HEATH, M.P.

VICE-PRESIDENTS:
Mr. G. P. HYSLOP. | Mr. G. A. MITCHESON. | Mr. JOHN NEWTON.

TREASURER:
Mr. THOMAS ASHWORTH.

SECRETARY:
Mr. F. R. ATKINSON.

COUNCILLORS:

Mr. G. J. CROSBIE-DAWSON.	Mr. A. HASSAM.	Mr. THOMAS ROBERTS.
Mr. W. H. DAVIES.	Mr. JOHN HEATH.	Mr. W. STATHAM.
Mr. G. H. GREATBACH.	Mr. G. E. LAWTON.	Mr. J. T. STOBBS.
Mr. JOHN GREGORY.	Mr. G. A. MILLWARD.	Mr. F. H. WYNNE.

Mr. J. C. CADMAN proposed a vote of thanks to the retiring President, eulogizing Mr. A. M. Henshaw for the energy which he had put into his work during the past two years; and observing that the way in which he had furthered the scheme of the Mining School would bear good fruit.

Mr. R. H. COLE seconded the motion and it was carried with applause.

Mr. A. M. HENSHAW, in acknowledging the vote, said that he had derived pleasure and profit from acting as president of the Institute during the past two years. He would always be ready to do what he could to promote the interests of the Institute.

The PRESIDENT (Mr. A. H. Heath) then took the chair, and delivered the following address:—

PRESIDENTIAL ADDRESS.

By A. H. HEATH, M.P.

In the first place, let me say that you have conferred a great honour on me, as well as a great pleasure, in asking me to preside over your Institute for this year. I have only one regret in connection with this appointment, and that is, that, having had Mr. A. M. Henshaw as President for two years, and finding him so very capable and so very willing to undertake the duties, it has fallen to my lot to turn him out of the chair. However, we hope that he may live long enough to find himself in the same position again at some future time. I can only say that I am very conscious of the great zeal, the great energy, and the great ability with which he has fulfilled his duties during his two years of office; and I only hope that during my year of office, if anything can compensate for my lack of ability in following in his footsteps, we shall see some practical result in the direction which he has already suggested.

Although I am very much interested in mines, I do not pretend for a moment to be, in any sense of the word, an engineer. Nothing interests me so much as mining engineering, and in fact, anything connected with mines—and especially the mines in the district of North Staffordshire—but I do not pretend to know anything at all about them. I have gained a pretty accurate idea from what is told me by those who do understand mining engineering, but I have never undertaken the responsibility of suggesting that any course was right or of suggesting that what those suggest, who know far better than I do, should be in any way interfered with. But, as a large colliery-owner and with nearly all I possess invested in the industy of mining, I naturally take the very deepest interest in the work in which you are engaged, and I feel that it is the very greatest pleasure that I can possibly have if I can give you any encouragement. I think that it is certainly the duty of anyone interested, as I am, in the mining industry to do everything that they possibly

can to make your living in every way more comfortable and less burdensome, and to give you every possible facility for promoting instruction in the profession in which you are engaged.

At the present time, we hear a good deal about the development of mines in every country, and statistics are from time to time published showing that the industry in Great Britain, if it is not going backwards, at all events is not holding its own in comparison with the industry in other countries. That may be so to some extent, owing to the natural resources in these countries and the increased facilities which other countries have, in various ways, of increasing work in this industry and many features in which labour in other countries differ from labour in this. I do not think that it is necessary to enter into them now, but I will say that those who organize labour and who really take a very earnest interest, as I believe they do, in the welfare of those whom they represent—I think that the best thing they can possibly do to our industry and to our fellow-workers is to try and stimulate in other countries the same organization which they maintain here, and encourage miners abroad to insist on the same conditions of labour as those which they have acquired in this country. That is rather beside the point, but, as I tell you, I am not an engineer, and I mention that as being a matter generally affecting the industries of this country. But, however much we may fall behind other countries in output and in the development of our resources, I am quite satisfied that we amply hold our own in the matter of engineering and invention for the working of mines, and this despite the fact that the facilities which we are offering to our engineers in this country and to young men who want to make themselves efficient in that profession, are not nearly so good as the facilities offered and encouraged by the Governments in other countries.

The new Government scheme of education is a difficult one to speak about without touching upon the political side of it; but it is a significant fact that nearly all the criticism of that Act is devoted to other subjects than education, and the only inference that I can draw from that is that, as far as the educational advantages which the new system is likely to confer are concerned, the public are fairly well satisfied with it. At all events, it has done something for the mining interest if it has enabled us to establish side by side with an institution which the

local authority is likely to set up here, a Mining School which has been the dream of the lives of many of those who wish to promote the real interests of North Staffordshire mining, and of the North Staffordshire mining engineer.

The controversy with regard to the improvement of our fiscal system, which is proposed with the object of helping our industries in this country, is one upon which I need not touch, but it is one that I consider of very vast importance and one about which I hold that we are likely to hear a good deal more shortly. I may tell you that I have always been in favour of the scheme which Mr. Balfour proposes in his Sheffield speech, and I am not by any means opposed to Mr. Chamberlain's more extensive view if I could be assured of its practicability. I consider that Mr. Balfour has done the right thing in insisting on and endeavouring to promote an inquiry into the opinion of the people of this country and of our Colonies. Whatever the outcome, I care not, but I must say that unless something is done to try and improve the condition of employers—those who spend their time and money in developing the industries of this country—there is no doubt that we shall very soon lose ground and a large number of our industries will be practically annihilated.

Those are two points which, I think, naturally suggest themselves to the minds of anyone who is discussing industrial problems to-day; but, so far as our Institute is concerned, I do not think that any country in the world is better served in the way of engineering and of invention than our own, and I do not believe that North Staffordshire falls behind any other district. Every encouragement, I think, is given by employers that can be given, but we have always felt that you have never had an opportunity of developing initiative among young men who take up engineering as their profession, in the way you ought to have. It would be, I think, by the establishment in the first place of such a Mining School as is proposed that such an opportunity would be given. There must be hundreds of young men in the district who go down the mines and work in them, many of whom become engineers of a rough order, but who have no opportunity of really finishing their education. It is such a facility as this that this school, which we propose to establish here, is likely to offer. There are many other advantages in connection with this school which, of course, will be of great service,

and which I may mention presently, but I may say that I look upon the school as virtually established. The colliery-owners have already contributed £1,500 towards the expenses of the building, and only £2,500 more are required to complete it. I do not think that the colliery-owners of this district are likely to throw away the £1,500 that they have already found, and I have every hope that before very long, with the pressure which this Institute will be able to put upon the owners, we shall be able to show them clearly enough the importance of raising the further £2,500. I do not know what the prospect of laying the foundation-stone may be, but the question of a Pupil Teacher Centre and a College for the Training of Teachers is so imperative at the present time that I do not think that the local authority will be allowed to continue without establishing that school in the immediate future. Thanks to the generosity of the late Mr. A. S. Bolton, an opportunity is afforded to the local authority for building the school on the ground given for the purpose, which I think they could hardly forego accepting. There could not possibly be a more central place for any such institution, and if it is decided to establish a Pupil Teacher Centre and the Training School for Teachers, such an opportunity is afforded for further development of the educational scheme in building a Mining School (and I hope a Pottery School also), as I think has never offered itself before. In that connection, I should like to impress very much on this Institute that we must look well into the cost of our share of this institution before we actually decide what the minimum price is. It may be that £4,000 is quite enough, but I should be very sorry indeed to go to colliery-owners and say that this sum of £4,000 is sufficient and then to ask them for another £1,000 or £2,000 in the next year or two afterwards. The colliery-owners are going, I suppose, to find the bulk of the money, and your Institute is going to be responsible for the conduct of the instruction and the general management of the school when it is established; so that I think it is for us to be quite clear on the subject of cost, before we go to them again and ask them to pay over to us the balance which is required. This institution is not only going to be a place for instructing the mining engineers of the future, but it is going to give facilities for conferences, for lectures, and for a library for your books and for the storing-away and keeping of

all your records and many plans and diagrams of mines, which are of the greatest possible value to all interested in the industry. I think also that as a social institution it will be of enormous value in enabling those engaged in the profession to meet together from time to time in social intercourse.

So far, I think we may be grateful for the assistance that we have had in the past from the County Council, by the lectures delivered in the district by Mr. J. T. Stobbs. Those who know anything of his work know that he has shown himself to be a most capable lecturer, taking the deepest and most scientific and practical interest in the mines of this particular district, and I do not think that it is possible to overrate the good work which he has done here.

Within the last twelve months, the laboratory at the Newcastle High School has been established, and we have had the advantage of the lectures there given by Dr. Mellor. I think that the district will gain very largely from the facilities and the highly scientific training offered to students in that school. I only hope that the outcome of this may be that we shall have growing up amongst us and working in our mines in North Staffordshire a highly trained class of young men, who will no doubt facilitate the working of our mines. I do not say that the student will be allowed to experiment in our mines, but still he will have scientific knowledge which I think will enable him to take advantage of the practical opportunities which are offered him. Further than that it will be the means, I think, of educating and turning out into the world a great many young men whose opportunities have been hopelessly stunted in the past.

I was very much interested the other day in reading about electrical ore-finding. I believe that it has been discovered by Messrs. L. Daft and A. Williams that electricity can be used to discover the position of ores in the earth by passing an electric current into the earth and noting the effect, very much in the same way that the effect of an electric current is notified in the telephone. Now, that is an invention which will appeal to all of us, if it can be proved, as of the very greatest possible value. It would have saved a great deal of money at Keele and Cheadle if it had been put into operation there. I am told that the method has been successful at Barrow in the discovery

of hæmatite; and in Alaska, I believe, gold has been found by its means, and other metals in other districts. Now, how very gratifying it will be if some day we can claim such an invention for any student of our own training.

Unless some better facilities are offered to the colliery-owners for raising coal at a cheap rate, and other conditions which will make the industry more economical to the promoters, I think that there really is a very bad time in store for the miners in this district. We want the very highest possible scientific training, the application of every facility which the inventive genius of engineers can apply, to lessen the cost of getting the coal, and this is becoming more and more important every day, as we have to go deeper into the bowels of the earth to recover our coal.

I hope that in my year of office there may be established, and some portion of it built, a school for giving these facilities in the district. The suggestion for starting a college for North Staffordshire was made in the first place by, I really know not whom; but I am not quite sure that it was not Mr. Macfadyen, the late Congregational minister at Hanley. Be that as it may, he was the first secretary, and he asked me to take the chair at the first meeting held at Hanley. I saw surrounding me very earnest and very capable people, but evidently they nearly all belonged to Hanley, and I told them at once that although I loved Hanley and thought that it was the most important place in the world, how very bad a start I thought they had made in holding the meeting there and having only those gentlemen present. Luckily the movement was carried into a larger field, and we decided on a wider course of action. That course of action was to appoint Mr. Brown the secretary of the movement, with a view of promoting the college in North Staffordshire. He has been at work now for five years, and I can only say that he has been paid very badly indeed. He is a man of the highest intellect, and a man of very great ability as a lecturer and certainly as an organizer too, and I say that we shall have to thank him to the fullest extent if the effort which he has made on behalf of this college bears any fruit. Only the other day he attended a meeting called by the Chamber of Commerce, and it was so sparsely attended that I felt quite sorry that he should express to them his oft-repeated views with regard to the college. If he had been here to-day he would have had a larger meeting, and

although that was a fairly influential one, as far as it went, this would have been still more influential, because I think that the industry is very fully and very well represented here to-day. The scheme has been laid before you in many ways—privately in a circular and publicly in the press; the fullest publicity has been given to it from time to time, and it only rests now for us to do the best we can, as far as the Mining School is concerned, towards raising the money at once. That is the object with which I have accepted the chair during the next year.

As the chairman has pointed out to you, I am, at all events for the time being, a busy man in other departments of life, and I may find myself so for some time, but there is nothing I enjoy more than coming to North Staffordshire and hearing, and more especially seeing, what is going on in the mines here. But whatever calls I have you may be sure that everything I can do will be at your service during my year of office, and if the meetings of the Institute take place at times when I am able to attend, you may be quite sure that I shall be there in person.

I thank you very much for the great honour which you have conferred on me in making me your president; and I hope that it will be a year of great prosperity for us all.

Mr. W. N. Atkinson proposed a vote of thanks to Mr. Heath for his valuable address. He (Mr. Atkinson) thought that there was now a good prospect of the Mining School being built, and they could not possibly have a better president than Mr. Heath to forward the scheme.

Mr. E. B. Wain seconded the proposition, which was carried with much heartiness.

THE MIDLAND COUNTIES INSTITUTION OF ENGINEERS.

ANNUAL GENERAL MEETING,

HELD AT UNIVERSITY COLLEGE, NOTTINGHAM, SEPTEMBER 3RD, 1904.

MR. G. ELMSLEY COKE, PAST-PRESIDENT, IN THE CHAIR.

The SECRETARY announced the election of the following gentlemen:—

MEMBERS—

Mr. THEODORE ASHLEY, Assistant Manager, Whitwick Colliery, Coalville.
Mr. REGINALD FERENS, Assistant Manager, Shirland, Alfreton.
Mr. MARK FRYAR, Mining Engineer, Denby Colliery, near Derby.
Mr. L. MULHOLLAND, Mining Engineer, Durban Navigation Collieries, Dannhauser, Natal.
Mr. W. REAVELL, Managing Director of Reavell & Co., Ltd., Ranelagh Works, Ipswich.

STUDENT—

Mr. GUY NICHOLSON, Mining Student, Clay Cross. Chesterfield.

The Annual Report of the Council was submitted as follows:—

ANNUAL REPORT OF THE COUNCIL, 1903-1904.

The following is a comparative summary of the number of members and the state of the finances for the last three years:—

	Year 1901-1902	Year 1902-1903.	Year 1903-1904.
Honorary Members ...	15	15	15
Life Members	8	7	6
Members	252	259	275
Associate Members ...	4	3	3
Associates	65	59	62
Students	31	29	37
Totals	375	372	398
	£ s. d.	£ s. d.	£ s. d.
Cash Receipts ...	535 1 0	477 14 9	631 5 0
Cash Payments ...	467 4 7	450 8 6	651 0 2
Bank Balance ...	172 2 10	199 9 1	179 13 11
Invested Funds	640 0 0	640 0 0	640 0 0
Totals ...	£812 2 10	£839 9 1	£819 13 11

The following table shows the alteration in membership during the past twelve months. "Resigned" includes those who have ceased to be members through the non-payment of subscriptions, and out of 21 resignations, 13 are due to this cause.

		Less			Add		
	1902-1903	Dead.	Resigned.	Transferred.	Elected.	Transferred.	1903-1904.
Honorary Members	15	—	—	—	—	—	15
Life Members ...	7	1	—	—	—	—	6
Members ...	260	1	14	—	23	7	275
Associate Members	3	—	—	—	—	—	3
Associates ...	58	—	6	—	10	—	62
Students ...	29	—	1	6	15	—	37
Totals ...	372						398

The Annual Meeting of the members of The Institution of Mining Engineers took place on September 2nd, 3rd and 4th, 1903, and was a great success. Large numbers of members attended the meeting and took part in the debates. The excursion on the second day to Sherwood colliery, Creswell colliery and Welbeck Abbey was patronized by 250 members; and that on the third day to Clay Cross Ironworks, Glapwell colliery and Hardwick Hall by 150 members. The Council wish to repeat and to record their thanks to the various persons and firms who have been kind enough to assist the Institution by their generous hospitality, not only on the above-mentioned occasions, but when local meetings have been held; and also for their kindness in throwing open their works for inspection. The London Meeting of The Institution of Mining Engineers took place on June 2nd, 3rd and 4th, 1904.

The following local meetings have been held:—Annual Meeting, Nottingham, August 29th, 1903; Chesterfield, December 5th, 1903; Joint Meeting with the Midland Institute of Mining, Civil and Mechanical Engineers, January 30th, 1904; and Nottingham, June 25th, 1904. In addition to these, an excursion to the Derwent Valley waterworks was arranged for April 26th, 1904, and was largely attended.

The practice of forwarding mutual invitations to the members of both "Midland" Institutes has been continued during the past year, with, it is considered, successful results.

The Council wish to express their satisfaction at the large

number of new members of all classes elected during the last twelve months. It is only by the continual influx of new blood that the status of the Institution can be maintained, and they hope that the increase shown in this year's numbers will be repeated.

The following papers have been contributed to the *Transactions* by members of this Institution, since the last Report of the Council:—

'Notes on Glapwell Colliery." By Mr. M. Deacon.
"Sherwood Colliery Sinking." By Mr. J. W. Fryar.
"The Three-phase Electric Haulage-plant at Shirebrook Colliery, Mansfield." By Mr. W. Hay.
"The Beard-Mackie Gas-indicator." By Mr. W. Hutton Hepplewhite.
"An Improved Roller-journal for Haulage-ropes." By Mr. A. B. Hewitt.
"Comments on the Proposed 'Rules for the Installation and Use of Electricity in Mines.'" By Mr. W. Maurice.

The Council has taken an active part in pressing for the more prompt and regular issue of the *Transactions*, and it is now hoped that more satisfaction will be given in this respect.

The CHAIRMAN (Mr. G. E. Coke), in moving the adoption of the report and statement of accounts, said that on the whole the year might be regarded as very satisfactory.

Mr. G. J. BINNS seconded the resolution, which was carried unanimously.

ELECTION OF OFFICERS, 1904-1905.

The report of the Scrutineers (Messrs. T. G. Lees and E. O. Burrows) was read as follows:—

PRESIDENT:
Mr. W. B. M. JACKSON.

VICE-PRESIDENTS:

Mr. G. J. BINNS.	Mr. T. G. LEES.	Mr. C. SEBASTIAN SMITH.
Mr. H. R. HEWITT.	Mr. J. PIGGFORD.	Mr. G. SPENCER.

COUNCILLORS:

Mr. G. H. ASHWIN.	Mr. W. HAY.	Mr. J. H. W. LAVERICK.
Mr. P. BEAUMONT.	Mr. W. H. HEPPLEWHITE.	Mr. B. MADEW.
Mr. G. C. FOWLER.	Mr. R. H. F. HEPPLEWHITE.	Mr. B. McLAREN.
Mr. J. W. FRYAR.	Mr. J. P. HOUFTON.	Mr. J. MEIN.

A cordial vote of thanks was accorded to the Scrutineers for their services.

Abstract of Accounts for the Year ending July 31st, 1904.

Receipts.

	£	s.	d.
Balance brought forward	199	9	1
213 Members at £1 11s. 6d.	335	9	6
6 Students transferred to Members	9	9	0
3 Associate Members	4	14	6
56 Associates and Students	56	0	0
22 New Members and Entrance-fees	57	15	0
1 New Member transferred	1	11	6
1 Attached Member	0	1	0
26 New Associates and Students	26	0	0
1 New Associate paid as Member	1	12	6
5 Transfer-fees	2	12	6
The Butterley Company	5	5	0
Subscriptions paid in advance	29	4	0
Sale of *Transactions*, etc.	11	13	5
Midland Railway debenture interest	15	5	0
Arrear Subscriptions paid	65	15	6
Midland Institute of Mining, Civil and Mechanical Engineers: share of expenses of joint meeting ...	2	7	11
The Institution of Mining Engineers: share of expenses	2	9	6
Bank interest	3	19	2
	£830	14	1

Audited and found correct,

JOHN HALL,

JOHNSON PEARSON,

Auditors.

August 10th, 1904.

Expenditure.

	£	s.	d.
The Institution of Mining Engineers:—			
Call 1903-1904:—Vols. xxvi. and xxvii.	327	15	0
,, 1902-1903:—Vols. xxiv. and xxv.	19	19	0
Transactions supplied on payment of arrears ...	25	0	0
Exchanges	4	0	0
Printing and stationery	34	5	10
Auditors	3	3	0
Reporting proceedings	6	18	2
Postages, parcels, etc.	21	5	11
Travelling and incidental expenses	7	16	6
Fees at meetings	1	14	6
Rooms for meetings	2	18	6
Guests at meetings, fire insurance, &c.	3	4	1
Secretary's salary, assistance and use of office	100	0	0
Rent of room for storage of *Transactions*...	2	10	0
Expenses of meeting of The Institution of Mining Engineers	89	9	11
Bank charges	0	17	3
Cheque book	0	2	6
Balance	179	13	11
	£830	14	1

Dr. THE TREASURER IN ACCOUNT

	£ s. d.	£ s. d.
267 Members as per List, 1903-1904		
7 of whom are Life Members		
260		
7 of whom paid in advance		
253 Members at £1 11s. 6d.		398 9 6
3 Associate Members, as per List		4 14 6
87 Associates and Students		
4 of whom paid in advance		-
83 Associates and Students at £1		83 0 0
6 Students to pay difference as Members and Transfer-fees ...		6 12 0
22 New Members and Entrance-fees		57 15 0
1 New Member transferred		1 11 6
1 New Member attached		0 1 0
26 New Associates and Students...		26 0 0
1 New Associate to pay difference as a Member		1 12 6
The Butterley Company		5 5 0
Subscriptions paid in advance:—		
4 Members	6 6 0	
1 Member partly paid	0 10 6	
7 New Members	18 7 6	
2 Associates	2 0 0	
2 New Associates	2 0 0	
		29 4 0
		£614 5 0
Arrears, as per last Balance-sheet, 1902-1903		130 6 0

Audited and found correct,
JOHN HALL,
JOHNSON PEARSON,
AUDITORS.

August 10th, 1904.

£744 11 0

WITH SUBSCRIPTIONS, 1903-1904. Cr.

	Paid. £ s. d.	Unpaid. £ s. d.	Struck off List. £ s. d.
313 Members at £1 11s. 6d.	335 9 6	.....	.....
25 Members unpaid	... ..	39 7 6	.....
1 Member deceased	.....	.....	1 11 6
6 Members resigned	.....	.....	9 9 0
8 Members struck off	.....	.....	12 12 0
253			
3 Associate Members	4 14 6	.....	.....
56 Associates and Students paid	56 0 0	.....	.....
14 Associates and Students unpaid ...	.....	14 0 0	.....
5 Associates and Students struck off ...	.....	.....	5 0 0
6 Students paid and transferred ...	6 0 0	.....	.....
2 Associates and Students resigned ...	.....	.....	2 0 0
83			
5 Students paid as Members and Transfer-fees	6 1 6	.....	.....
1 Member unpaid Transfer-fee ...	.....	0 10 6	.....
22 New Members and Entrance-fees ...	57 15 0	.....	.....
1 New Member transferred	1 11 6	.....	.....
1 New Member attached	0 1 0	.....	... ..
26 New Associates and Students ...	26 0 0	.....	. ...
1 New Associate paid as a Member ...	1 12 6	.....	... ..
The Butterley Company	5 5 0	.....	... ..
Subscriptions paid in advance	29 4 0	.....	.....
	529 14 6	53 18 0	30 12 6
Arrears	65 15 6	25 3 6	39 7 0
	595 10 0	79 1 6	69 19 6
			79 1 6
			595 10 0

£744 11 0

DISCUSSION OF MR. W. HAY'S PAPER ON "THE THREE-PHASE ELECTRIC HAULAGE-PLANT AT SHIREBROOK COLLIERY, MANSFIELD."*

Mr. G. A. LEWIS (Derby) said that it seemed to him that in the recent discussion Mr. Hay was criticized somewhat severely on some figures which the paper contained. The object of the paper, however, was not to show that 30 per cent. was taken up by the engine and counter-shaft, or that the quantity of steam used was something upon which Mr. Hay might be congratulated (indeed he specifically disclaimed any credit for the machinery in question); but Mr. Hay wished to bring before the members the point that the three-phase system was one eminently suited for colliery-work. He (Mr. Lewis) thought that the details of the plant and its advantages were extremely well put, in a paper recently read by Mr. Roslyn Holiday†; and he did not think that anyone who read that paper would fail to appreciate the advantages of the three-phase system. The simplicity of the machinery, the fact that brushes and commutators were not required, and that all the parts of the motors through which high-tension current was passing was stationary, were all great advantages; and, as they were all more or less interested in electricity, and would all most probably have to put down in time an electrical plant of greater or less capacity, he asked Mr. Hay whether he meant to recommend the general adoption of the three-phase system for use in collieries.

Mr. HAY said that when he wrote the paper his intention was really to try to find out the difference in efficiency between a three-phase motor and a continuous-current motor, of the same power and working the same plant. He was, however, so afraid of giving the results together (for he did not know what the effect might be, if they had a number of electrical engineers at the meeting) that he limited himself to the three-phase system in the present paper. It was his intention to drive the same haulage-plant with a continuous-current motor, with precisely the same engine and the same plant; he hoped to record the results in another paper, and he thought that the comparison would be interesting. He did not anticipate that the continuous-

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 282

† *Ibid.*, 1904, vol. xxvii., page 410.

current would be better than the three-phase plant, and if he had to put down another electrical plant he would put down a three-phase one. It was simplicity itself, and nothing could go wrong if it were kept well lubricated. Sometimes there was a little difficulty at starting, but once the motor had been started there was no difficulty whatever. They had tried to reduce the power absorbed by the engine and counter-shaft, but without success, and the only way that they could see was to dispense with the counter-shaft.

DISCUSSION OF MR. W. MAURICE'S "COMMENTS ON THE PROPOSED 'RULES FOR THE INSTALLATION AND USE OF ELECTRICITY IN MINES.'"*

Mr. W. MAURICE said that, so far, his observations on the practical workability of the rules had not been seriously contested. He therefore felt justified in concluding that there was no answer to the point of view that he had set forth. From the reports he had seen of discussions on the proposed rules at other centres, he thought that much more might be said as to their probable influence. He understood that many of the rules had been amended, but he was still unable to see that they were practicable and desirable, when considered as prospective mining laws. As general recommendations, tending towards the improvement and effective maintenance of electrical installations, the bulk of the rules obviously possessed practical utility, since they were borrowed from everyday electrical practice.

It was not so much the rules themselves to which he objected so strongly: it was the parochial attitude of mind, which conceived the idea of turning such a set of copy-book maxims into mining laws. Prof. Horace Lamb, in his Presidential Address to the Mathematical and Physical Section of the British Association for the Advancement of Science, said, incidentally, "a rule is invented in the first instance to sum up in a compact form a number of past experiences."† A number of the rules now submitted were not the result of past experience. They were designed to prevent something, which had never been known to occur. The "intelligent anticipation of events" might be

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 290.

† *The Times*, August 19th, 1904, page 4, second column.

very excellent in a journalist, but it was scarcely commendable as a basis for law-making. He hoped that the authorities would recognize the impracticability of making such rules compulsory, and felt sure that they would serve their purpose adequately, if in a modified form they were submitted as advisory regulations.

Mr. ARTHUR B. MARKHAM, M.P., said that as he was the father of the proposed rules—inasmuch as he persuaded the Government to appoint the Departmental Committee to enquire into the use of electricity in mines—he would say a few words upon the proposed rules, especially as he had been concerned in using electricity on perhaps as large a scale as any other mining engineer in the country. There could not be any doubt that it was absolutely necessary that there should be a code of rules, now that this powerful agency of electricity was so largely in use at the present time. There had been during the last one or two years, over 12 deaths, resulting from the use of electricity in mines; and he thought that there could not be any doubt, unless rules of a more or less stringent character were brought into operation, that the death-rate would continue to rise. It was the duty of the State primarily to make rules for the protection of the lives and limbs of all those who were incidentally connected with mining; but it was not the duty of the State, when that point had been reached, to interfere in the conduct of the mines. And although, no doubt, a great deal was to be said in support of the proposed rules—drawn with the most extreme care by those who had given very careful attention to the subject—there were a considerable number to which exception might be taken.

H.M. inspectors of mines, in his opinion, were not the proper persons to carry out the application of the proposed rules. Certainly an inspector of mines like Mr. A. H. Stokes, who had a wide experience of electricity and had made a study of it, would be a most competent and admirable person to do so, but they must take the country as a whole—they were not discussing the question merely as it affected the Midland mines-inspection district in which they lived. The majority of H.M. inspectors of mines had no practical knowledge whatever of the applications of electricity, beyond what they had learned by going from one colliery to another. It was not fair that an

nspector of mines, who had not passed an examination in elec-
ricity when he obtained his certificate, should have absolute
ontrol over what a manager was to do or what he was not to do,
hen that manager might be more competent to say what was
est from a practical point of view than an inspector of mines.
[e had urged that the application of the proposed rules should
e enforced by inspectors appointed *ad hoc*. The Government
ought that this suggestion deserved careful consideration; and,
ithout disclosing anything of a private nature, he might say
hat at present the matter rested as follows:—If it were found
iat friction arose between colliery managers and H.M. inspectors
f mines, then, he understood, the Government would appoint
lectrical inspectors, who had had practical knowledge of mining
ork; and he suggested that gentlemen, who had had a wide
xperience of mining and who had a knowledge of electricity
ke Mr. Stokes, would be better than those who were only elec-
rical experts and who had no knowledge of mining.

Rule 27, section I., provided that no colliery manager should
ut down a motor without first sending notice in writing to H.M.
nspector of mines, and he thought that that was approaching
ery closely to the point of grandmotherly legislation.

With regard to the question of cables (section III.), as he was
alking through the streets of Nottingham that day he thought
hat the overhead-trolley system supplied a good illustration.
Iere they had, as in other towns, bare overhead wires where
here was a constant rolling contact. It was, according to the
ules of the Board of Trade, safe to carry a bare overhead wire
n the crowded streets of the city of Nottingham, but it was not
afe, according to the opinion of the Departmental Committee,
ho drew up the proposed rules, to have, in a colliery-yard, over-
ead wires in connection with which there was no moving con-
act—at any rate it was proposed that there should be no traffic
nder overhead wires. Mr. Stokes apparently overlooked the
act that rule 14, and sub-section *d*, definitely stated:—"It shall
e permissible to use on the surface bare overhead wires under
he following conditions . . . . The overhead lines shall at
every part be absolutely clear of any traffic going under them."
This rule, if insisted on, would close two collieries with which
he was connected, until those wires were taken down. He
would strenuously object to these wires being taken down, for

they were put up under conditions far more stringent than those required under sub-section *a* of the same rule. He would ask the members to bear in mind that the wires in the streets of Nottingham were contact-wires, with which a trolley was constantly in contact. In the cases to which he referred, the wires were rigidly attached to poles, and there was nothing in contact with them; yet in the opinion of the Departmental Committee these wires ought not to be allowed. Such wires were, of course, far safer than wires fixed for an overhead-tramway system; yet on pit-banks, where traffic was going on in the form of moving tubs, the use of bare wires was prohibited—it was therefore unreasonable that this section should apply, and he hoped that it would be amended.

Rule 9, section III., enacted in the most stringent terms that the current density should not exceed 1,000 ampères per square inch: he maintained, as it had nothing to do with protecting the lives of the men, that it was outside the scope of State interference. What did it matter to the Government if he choosed to use 2,000 ampères per square inch on a bare overhead wire? It was an uneconomical method of distributing current; but the Government should not interfere, provided that no danger accrued to the lives of the men and the safety of the mine.

In rule 2, section V., they were told that every motor should be provided with an ammeter. He objected to that rule, and he did not see that any safety could be afforded by attaching an ammeter to each motor. Three-phase systems were likely to be used in the near future, instead of continuous-current systems; and in three-phase work accidents would not in the least be prevented by using ammeters, which were difficult to read and very unreliable.

Recently, he had a conversation with Sir Alexander Siemens on the subject of the cable-tests (rule 3, section III.) recommended by the Departmental Committee. Sir Alexander Siemens said that the tests made by his firm on all the cables that they supplied were more stringent than those suggested by the Departmental Committee, and that any cables which could not pass the tests recommended by the Departmental Committee could not be considered of first-class quality. With that observation he (Mr. Markham) entirely agreed. He was not clear

whether H.M. inspector of mines had a right to cut off a piece of cable, after it had been in the mine for perhaps 2 years, and subject it to the tests to which it was subjected when it was bought by the colliery owner. The conditions of mines were such that very serious deterioration took place in most cables; and when they had tests for boilers and chains, it was only sensible and reasonable that they should have tests equally applied to cables on which the lives of men and the safety of the mines depended.

Everybody always spoke in favour of good work, but when it came to paying for it, some people demurred to good work, as the cost was something like 20 per cent. more than an inferior standard of work. An immense amount of inferior plant had been put into mines, no doubt owing to the fact that electrical manufacturers had, unfortunately, to gain their experience, at the expense of the coal-owners. He (Mr. Markham) introduced electric coal-cutters into the south Midland district, and the motors then supplied were put on the scrap-heap in a few weeks' time. However, to-day, they had passed the experimental stages, and three-phase coal-cutters and also continuous-current machines had (with the best makers) reached a high standard of excellency. Cheap inferior work was a source of incessant trouble to managers and a loss to coal-owners.

There was an important point which must not be forgotten, and that was the position of colliery managers under the proposed rules. In his (Mr. Markham's) opinion a colliery manager ought not to be responsible under certain circumstances for accidents, which might occur in mines, whether the proposed rules were broken or not. The adoption of the proposed rules would throw a very grave responsibility upon colliery managers, and it was not fair—especially in bad times—that they should have to bear that responsibility when the question rested much more with the owners themselves, who decided from time to time whether plant should be made cheaply, or whether it should be made with the best material that could be obtained. He had urged on the Home Secretary that the responsibility for the proper application of the proposed rules ought not to be thrown upon colliery managers. A manager would be able to plead that he had done his best: he could not be everywhere, and these rules would cause a great amount of labour and anxiety every-

where. His duties were sufficiently onerous at all times, and the loss of his certificate meant the loss of his livelihood. If a colliery manager employed a competent person, and had devolved a part of his work on that competent person, he should not be prosecuted or lose his certificate, unless it could be shown that he had been culpably negligent and had thereby caused loss of life. The reply which the Home Secretary gave him was that, before taking proceedings, it was the duty of H.M. inspectors of mines to consider who was responsible—whether the owner or the manager. Possibly, the colliery manager might have to "give away" his employer, for the proposed rules were entirely different from any hitherto brought into force in mines, and a manager might have carried them out to the best of his ability in accordance with the appliances which had been given to him. He (Mr. Markham) suggested that a colliery manager should keep a report-book, and that he should from time to time make recommendations to his directors as to where, in his opinion, expenditure was necessary for the protection of the mine. If the owners failed to carry out those recommendations, or made no provision in other directions, then he considered that in all such cases the responsibility should pass from the colliery manager and devolve upon the owners.

Mr. A. H. Stokes (H.M. Inspector of Mines) observed that Mr. Maurice complained that some of the rules were made to meet something which had never occurred, while a little later he said that most of the rules were now in force; but he (Mr. Stokes) could not quite reconcile the two statements. Of course, some rules were made to meet anticipated dangers; and rules must be made to cover what might occur as well as what had occurred. Mr. Maurice said that the rules could not be carried out every day; but there were now many statutory rules which were not carried out every day, because the circumstances to which they were applicable did not arise. There was a rule, which required that bore-holes should be made when places were approaching old workings; but bore-holes were not made every day, because they knew that they were not always approaching old workings. Mr. Maurice also remarked that these were excellent rules, and that they should carry them out. He (Mr. Stokes) was quite content to rest there, but Mr. Maurice rather spoilt the remark by his next sentence, which stated that in his

opinion the rules should not be compulsory but voluntary. Was there any one in that room who would hold up his hand and say that the present Special Rules should be voluntarily and not compulsorily enforced?

Mr. Markham thought that H.M. inspectors of mines were not competent to administer electrical rules or to deal with electrical installations; but were managers competent electricians? If managers and H.M. inspectors of mines were not competent to secure safety, and to understand the elementary principles of electricity as they understood the principles of steam and mechanics, then the sooner they all made themselves competent the better. Colliery managers were not required to pass an examination in finance when they went up for their certificates, but some of them were remarkably successful in securing good dividends. If colliery managers were not competent and H.M. inspectors of mines were not competent to secure safety, they must both make themselves competent. Mr. Markham asked why the Government should specify the number of ampères per square inch of cable which should be permitted, but there was a statutory rule which specified the number of parallel wires to the inch for safety-lamp gauze. Why should they not state the maximum number of ampères passing through a wire, as well as the maximum number of perforations in a gauze? They must remember in considering the proposed rules that while they were intended for safety, yet they were also made for guidance. Mr. Markham agreed that the cable-tests were not too severe, and he had one of the best authorities in the country behind him. He agreed with Mr. Markham that there had been a large amount of inferior electric plant erected, and probably many accidents were due to that cause. If the effect of the proposed rules was only to secure good work, they would have answered a useful purpose. If he were giving out an order to an electrical firm, he thought that he would ask for an estimate for the work required, and then hand them the report of the Departmental Committee, telling them to take that as the standard with which they would have to comply. If colliery owners did that, they might depend upon it that they would get good work. Mr. Markham urged that the responsibility should not be placed upon the manager: upon whom then should it rest—H.M. inspector of mines? He (Mr. Stokes) would be quite content to

take the whole of the responsibility as a colliery manager, for any plant which might be put down: on one condition, and that was that if he had the responsibility, he should have unlimited control as to the ordering of the plant and the quality of the work to be put down.

Mr. L. W. DE GRAVE (Derby) said that, taking the proposed rules as a whole, there was very little to which serious objection could be made. Mr. A. H. Stokes had stated that the rules were very flexible: in his opinion there was a great want of flexibility about them, but even as they stood there was no doubt that they would be an excellent guidance to colliery owners and managers in installing, and above all maintaining, a plant. The interpretation of the rules was an important point, and he did not think that many owners and managers would care to have the interpretation left to an inspector of mines. When technical points were to be interpreted, it would be only proper for them to be interpreted by a technical man.

There were a number of rules, in which the wording might be made clearer, for instance, "pressure" might with advantage be described as "— volts normal working pressure." Again, reference was made to a "large system" without the size being in any way defined, although from 200 horsepower being referred to in one place possibly this was intended as the standard. But no useful purpose could be served by limiting or defining "size": whatever conduced to safety in the one would also apply to the other.

The limiting of the size of a motor in the case of high pressure was reasonable, although the limit chosen was unnecessarily high and might with advantage be reduced to 50; and in the case of transformers, if alternating current, there was no need to limit the size, as they were invariably made up in iron cases and generally again enclosed in either a water- or oil-jacket.

The maximum leakage was an impossible one, and it would conduce to satisfactory working if the insulation-resistance were determined for each case separately. In any event, it should be "insulation-resistance" and not "maximum leakage."

The rules as to tests *in situ* at high pressures before being brought into use were most undesirable, although as makers' tests they were hardly as stringent as every-day practice.

The rule as to the railing of a switchboard seemed rather an anomaly, inasmuch as a rail was put up to keep a man "off" the board, but in order to work he had to go "between" the board and the rail; whereas it would appear much simpler to rail off the board, and let the attendant do what was required with the railing between himself and the board.

The current-densities should be much more flexible, and there was no reason to enact that there should be any definite limit to this (except in hot places): a statement that the current-density should not as a rule exceed 1,000 ampères per square inch would meet all ordinary cases; and 2,000 ampères per square inch of current-density would not produce any appreciable rise of temperature in a cable.

Oil-brakes for switches and fuses were very far from being a success, and it would be a pity if their recommendation in the proposed rules were to lead to their introduction before being improved.

It was not desirable to define too closely the temperature-rise of a motor. Many people preferred to give the armature a short life, and as this rule stood there was no provision for motors on intermittent work, in which the temperature-rise for the short periods required might be almost anything, if worked out on the basis of a 6 hours' run.

It should be made clear in rule 5, section VI., that fixed motors may be worked from a trolley-line.

The importance of earthing the frames of machines had not been nearly sufficiently emphasized in the proposed rules, for, as they stood, the rules had been complied with if the frame of the machine was connected to the rails, which was really worse than leaving the frames unearthed. The Board of Trade had for a number of years enforced very stringent rules as to the earthing of machine-frames, etc., and it would be as well if the requirements of safety in this respect were made very clear. Briefly, it might be stated that there should be a continuous metallic connection from the frame of each motor and accessory right back to the generating-station: the armourings of cables being used, if such were provided, or if not, a separate conductor being employed. In the case of flexible cables, this earth-connection could most conveniently be arranged by having a small additional connection made up in the same cover as the flexible,

and making provision for connecting one end to the motor-frame and the other to the metallic case of the terminal or switch-box.

In section VIII. there should be a switch or button on each main (rule 6); and signal-wires should be included with power- or lighting-cables (rule 8).

There was one point on which the proposed rules might possibly give a false impression; and that was that from the multitudinous references to switches, fuses, junctions, terminal boxes, starting switches, and general accessories, some people might be led to suppose that safety lay in the multiplication of these accessories, whereas the opposite was the case, and every unnecessary accessory, which might be introduced, was creating one more weak spot.

The general arrangement of the proposed rules was probably the worst part about them, as they involved a number of repetitions and cross-references.

Apart from any rules, good, bad or indifferent, it should always be remembered that it was in the proper maintenance of a plant, and especially the cables and accessories in or near the coal-face, that true efficiency, economy and above all safety, was to be found.

Mr. B. McLaren (Pye Hill) said that the dangers of armoured cables, be they ever so well insulated, were so great as to cause him to have very little faith in the very best of them. They were open to so many sources of damage that he would not like to introduce an armoured cable for the purpose of earthing a coal-cutting machine.

The Chairman (Mr. G. E. Coke) remarked that it was obvious that the introduction of electricity in mines must be under regulation. In framing rules, it was desirable that they should not be incapable of amendment or of such a character as to check progress. Abroad, he had seen methods, not in favour in this country, such as the trolley-wire underground; and, without expressing an opinion on the merits, he thought that we should have an open mind in considering other practices. Mr. Maurice's paper was valuable in itself, and even more so from the discussion that it had produced.

DISCUSSION OF MR. A. B. HEWITT'S PAPER ON "AN IMPROVED ROLLER-JOURNAL FOR HAULAGE-ROPES."*

Mr. W. Hay observed that he had from 500 to 1,000 of the roller-journals at work at Shirebrook colliery. They did their work exceedingly well, but he drew the line at the large amount claimed for the saving in oiling. Lubricating the new journal once a week was quite sufficient, but it appeared that the comparison was made with an old type of journal, which was oiled four times a day. The roller-journal was a simple contrivance, it was efficient in preventing tubs from getting off the road; and there were not nearly so many mishaps now on the engine-plane as there used to be.

Mr. A. B. Hewitt said that with the old type of journal, every time the spindle became dry, it was oiled; and if they were to keep it in working order it must be oiled four times a day. The figures given in the paper were not estimates, but were the result of careful tests. The cost of the improved roller-journal was 15s. per cwt., comprizing 28 pairs.

Mr. G. J. Binns moved a vote of thanks to Mr. Hewitt for his paper.

The Chairman (Mr. G. E. Coke) seconded the resolution, which was cordially approved.

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* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 319.

MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.

ANNUAL GENERAL MEETING,

HELD AT THE ARCADE HALL, BARNSLEY, JULY 23RD, 1904.

MR. H. B. NASH, RETIRING-PRESIDENT, IN THE CHAIR.

The minutes of the previous General Meeting were read and confirmed.

Mr. John Wainwright and Mr. Hiram Baddiley were appointed scrutineers for the balloting-papers for the election of officers, and also for representatives on the Council of The Institution of Mining Engineers for 1904-1905.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

Mr. JAMES PERCIVAL CRITCHLEY, Mining Engineer, Batley Hall, Batley.
Mr. HORACE JOHN GREAVES, Manager, Messrs. Graham, Morton & Co., Le
Mr. HERBERT ALEXANDER JONES, Electrical Engineer, 40, Dalby Lane, Th bury, Bradford.
Mr. GEORGE NORMAN ACKROYD PITT, Colliery Manager, Bentleigh, New Huddersfield.

STUDENTS—

Mr. FREDERICK ALWYN BATTLE, Mining Student, 18, Clarendon Road,
Mr. HARRY WOOLLEY HART, Mining Student, Glass Houghton Co Castleford.
Mr. GEORGE AUGUSTUS LONGBOTHAM, Engineer Student, Walton Wakefield.
Mr. FRANK TIFFANY, JUN., Mining Student, 3, Kelso Road, Leeds.

The Annual Report of the Council and the State Accounts for the past year were read as follows:—

ANNUAL REPORT OF THE COUNCIL, 1903-1904.

The Council have pleasure in presenting to the members of the Institute their report on the work of the past year.

The number of members for the last two years is as follows:—

	1902-1903.	1903-1904.
Members	258	273
Associate Members	11	10
Associates	15	10
Students	11	12
Totals	295	305

From this table, it will be seen that the membership has increased by 10 during the year, an increase which is fairly satisfactory.

The Council regret to have again to state that there has been during the year some irregularity in the payment of subscriptions, the arrears amounting to £21 due from 14 members. Of the £15 arrears of subscriptions due for 1902-1903, £4 10s. have been collected during the past year.

There is a balance in the bank of £240 8s. 1d. against £191 10s. 11d. at the end of the previous year, and all debts owing by the Institute have been paid.

The following papers have been read during the year:—

"Ankylostomiasis: The Worm-disease of Miners." By Mr. F. W. Gray.

"An Electrical Heading-machine." By Mr. P. C. Greaves.

"Slack-washing: Preliminary Treatment for the Extraction of Fine Dust." By Mr. W. McD. Mackey.

"The Transmission of Errors in Traverse-surveying." By Prof. G. R. Thompson.

"The Dürr Water-tube and Improved Lancashire Boilers." By Mr. S. J. Thompson.

Several very interesting and valuable discussions have taken place upon papers read before other branches of The Institution of Mining Engineers.

It is with extreme regret that the Council have to call the members' attention to the great scarcity of papers. It is very important that this Institute, representing so large a district, should provide its fair share of papers towards the *Transactions* of The Institution of Mining Engineers, and the Council would be glad if members would consider this matter seriously with the view of submitting communications upon some practical subject in connection with their respective work, during the coming year.

The attention of the Council has been drawn by members

of the Institute to the great delay in the issue of the *Transactions*, and a portion of the blame is attributed to the fact that members do not prepare their papers and place them in the hands of the local Secretary early enough to have them printed before the meetings. It would be of great assistance, therefore, to the Council, and would help very much in the better and earlier production of the *Transactions*, if members could conveniently write their papers, say, a month before the meeting at which they have promised to read them.

The Council are very desirous of tabulating the various sections of strata which have been proved in this district, and with this object they have issued circulars and forms for the purpose. The Council hope that members will fill up the forms, giving all the information that they possibly can, so as to make the record a valuable one for future reference.

Mr. M. H. HABERSHON moved the adoption of the report.

Mr. H. ST. JOHN DURNFORD seconded the resolution, which was adopted.

ELECTION OF OFFICERS, 1904-1905.

The SCRUTINEERS reported the result of the ballot, as follows:—

PRESIDENT:

Mr. T. W. H. MITCHELL.

VICE-PRESIDENTS:

Mr. J. R. R. WILSON.	Mr. M. H. HABERSHON.	Mr. ISAAC HODGES.

COUNCILLORS:

Mr. J. E. CHAMBERS.	Mr. ROSLYN HOLIDAY.	Mr. CHARLES SNOW.
Mr. H. ST. JOHN DURNFORD.	Mr. J. L. MARSHALL.	Mr. THOMAS STUBBS.
Mr. THOMAS GILL.	Mr. W. H. PICKERING.	Prof. G. R. THOMPSON.
Mr. WALTER HARGREAVES.	Mr. HARRY RHODES.	Mr. W. WASHINGTON.

REPRESENTATIVES ON THE COUNCIL OF THE INSTITUTION OF MINING ENGINEERS, 1904-1905.

Mr. W. H. CHAMBERS.	Mr. T. W. H. MITCHELL.	Mr. J. NEVIN.
Mr. W. E. GARFORTH.	Mr. H. B. NASH.	Mr. W. H. PICKERING.
	Mr. J. R. R. WILSON.	

The PRESIDENT (Mr. T. W. H. Mitchell) moved a vote of thanks to the Retiring President.

Mr. JOHN GERRARD seconded the motion, which was unanimously approved.

Dr. The Treasurer (Mr. T. W. H. Mitchell) in Account with the Midland Institute of Mining, Civil and Mechanical Engineers, 1903-1904. Cr.

	£	s.	d.	£	s.	d.
July 1st, 1903.						
To Balance at bankers	191	10	11			
,, Cash in Treasurer's hands	1	11	1½			
				193	2	0½
June 30th, 1904.						
To Subscriptions for 1903-1904, 300 at £1 10s.	450	0	0			
,, Arrears, 1902-1903, 3 at £1 10s. ...	4	10	0			
,, ,, 1901-1902, 1 at £1 10s. ...	1	10	0			
,, Subscriptions paid in advance for 1904-1905, 3 at £1 10s.	4	10	0			
				460	10	0
,, Sale of dinner tickets, 85 at 5s. ...	21	5	0			
,, Wine account	1	17	3			
				23	2	3
,, Letting of room				1	7	6
,, Sale of *Transactions*, and authors' copies				1	14	0
,, Bank interest				8	2	1
,, Midhope excursion and dinner ...				8	7	6
				£696	5	4½

Examined and found correct,

M. H. HABERSHON,
THOMAS GILL,

AUDITORS.

July 19th, 1904.

	£	s.	d.	£	s.	d.
June 30th, 1904.						
By The Institution of Mining Engineers:—						
Call of 19s. per Member on 304 Members	288	16	0			
Balance of call for 1902-1903, 2 at 19s.	1	18	0			
Balance of call for 1901-1902, 1 at 20s.	1	0	0			
Excerpt *Transactions*, etc.	6	12	3			
Proportion of cost of exchanging *Transactions* with other societies ...	4	0	0			
Authors' copies	0	15	6			
				303	1	9
,, Annual dinner				28	3	4
,, Printing and stationery				15	0	2
,, Rent of room				12	0	0
,, Reporter				7	10	0
,, Insurance				1	11	6
,, Cleaning				0	12	0
,, Electric light				0	0	8
,, Hire of rooms for meetings at Leeds, Sheffield and Doncaster				3	1	6
,, Secretary's salary				50	0	0
,, ,, expenses				7	5	0
,, Stamps, telegrams, wrappers, carriage and sundries				14	0	8
,, Midhope excursion, dinner and conveyances ...				8	11	6
,, Share of joint meetings				2	7	11
,, Balance at bankers	£240	8	1			
,, Cash in Treasurer's hands	2	11	3½			
				242	19	4½
				£696	5	4½

MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.
GENERAL STATEMENT, 1903–1904.

LIABILITIES. 1904.	£	s.	d.	ASSETS. 1904.	£	s.	d.	£	s.	d.
June 30th.—None.				June 30th.—By Cash in bank	240	8	1			
„ To Balance, being capital	611	11	4½	„ „ „ Treasurer's hands ...	2	11	3½			
								242	19	4½
				„ „ Value of 7,093 parts of *Transactions*, at 1s. ...	354	13	0			
				„ „ Value of 115 copies of Narratives of Sudden Outbursts of Gas, at 1s.	5	15	0			
				„ „ Value of 116 copies of Committee's Report on Safety-lamps, at 1s.	5	16	0			
				„ „ Value of 16 copies of Report of French Commission on Use of Explosives, at 3s. ...	2	8	0			
								368	12	0
	£611	11	4½					£611	11	4½

Examined and found correct,
M. H. HABERSHON.
THOMAS GILL,
AUDITORS.

July 19th, 1904.

SION OF MR. W. H. PICKERING'S "NOTES ON SYSTEMATIC TIMBERING."*

. HODGES said that, when reading Mr. Pickering's paper, nuch struck with the fact that the number of fatal was not a satisfactory basis by which to judge the a mine. He had found that they had more notifica- ccidents since the introduction of the Workmen's Com- Act, and as the collieries now get an absolutely true all accidents, they had much more information at their han any inspector of mines could have. It was possible series of fatalities in what was probably not the most ear from the point of view of the number of accidents. me time, judging from the number of fatalities only, might be supposed to have had a good year, when cidents had left a number of men incurably crippled. ıore reason to look into this matter, since Mr. Picker- r was read, as he had gone thoroughly into the question ; where they had had the most serious accidents, and, they spent a great deal on extra timber and systematic ;, the number of fatalities had doubled. He found, that the number of accidents had shown a great ın, and it was by sheer bad luck that the number es had turned out so large. He also found in the pits charge, that the extended use of large lids (22 inches hes by 3 inches) had led to considerable economy in the ion of props. He thought that it was better that a nber of props should be securely set, rather than that should be overcrowded with much timber carelessly set. ples were useful to prevent coal from bursting off the face. The cost of bent bars was a heavy item, and the nt that he had made with iron bars had not been al.

[. H. HABERSHON said that he had for some time used ink bars, fixed as shown by Mr. Pickering in his plan,† ound them very satisfactory, particularly in thin seams y coal-cutting machines. The bars, made of steel, ches wide by 1 inch thick.

*. *Inst. M.E.*, 1902, vol. xxiv., page 95 ; and 1904, vol. xxvii., page 62.
, 1902, vol. xxiv., plate III., page 100.

Mr. W. H. PICKERING said he was glad to know that an effort had been made to deal with the important matter of systematic timbering—important both as regarded economy and safety. There were 69 fatalities in the Yorkshire mines-inspection district in 1903, and he believed that it would have been possible, if the miners and officials had been educated in proper methods, to have avoided a large proportion of them. The Coal-mines Regulation Act simply said that the inspector should be notified of all serious accidents, and different managers had different views as to what that meant. Mr. Hodges imagined that he was using big lids, whereas he (Mr. Pickering) could show him a mine where the lids were 45 inches long by 8 inches square. He did not describe the system shown on the plan as a model system, but only as an example of what could be done under a bad roof by systematic timbering. There was no theory or anything else about it: it was drawn from an actual working-place, and it was a method devised by a practical pitman before the phrase "systematic timbering" had ever been thought of.

Mr. MAURICE GEORGI read the following "Notes and Considerations on Systems having Work of an Intermittent and Irregular Character to Perform: Methods of Load-compensation":—

NOTES AND CONSIDERATIONS ON SYSTEMS HAVING WORK OF AN INTERMITTENT AND IRREGULAR CHARACTER TO PERFORM: METHODS OF LOAD-COMPENSATION.

By MAURICE GEORGI, B.Sc.

In the present notes, the writer's intention is not to treat of any subject in particular, but rather to give an elementary explanation of various questions that arise in connection with winding-engines, rolling-mills, etc., which might offer some interest to his fellow members; the more so that some of the problems that are dealt with to-day have not to his knowledge received as yet the attention which their importance would justify.

In this paper also will be found a somewhat lengthy explanation of the various compensating and starting devices for electrically-driven machinery, some of which may present a touch of novelty.

The Maximum Winding Speed in Shafts.

Let P be the weight of coal to be raised in a given period, T; p the weight wound each time; and r the depth of the winding shaft. The time required to make one wind will be $Tp \div P$ seconds. Let V_{max} be the maximum speed reached once all the masses are accelerated, and j the chosen coefficient of acceleration, noting, so as not to complicate the problem, that the coefficient of retardation is assumed equal to $1{\cdot}5j$, which is as a rule the case. We therefore obtain the equation:—

$$\frac{Tp}{P} = \frac{V_{max}}{j} + \frac{V_{max}}{1{\cdot}5j} + \frac{r - V^2_{max}\left(\frac{1}{2j} + \frac{1}{3j}\right)}{V_{max}} + Kp.$$

K is a coefficient equal to about 10, if tubs holding 10 cwts. of coal are used, and 5 if the same hold 30 to 35 cwts.

Reducing we get:—

$$\frac{5}{6j}V^2_{max} - pV_{max}\left(\frac{T}{P} - K\right) + r = 0 \quad . \quad . \quad . \quad (1)$$

This equation, in p and V_{max}, represents a hyperbola, whose centre is the origin of the co-ordinates and whose asymptotes are the lines:—

$$V_{max} = 0; \text{ and } \frac{5}{6j} V_{max} - p\left(\frac{T}{P} - K\right) = 0. \quad . \quad . \quad (2)$$

We see that this hyperbola is a tangent to the lines:—

$$p = \pm \sqrt{\frac{\frac{4 \times 5}{6j} r}{\left(\frac{T}{P} - K\right)^2}},$$

as the curve can have but imaginary points between the two lines represented by this equation (Fig. 1, Plate IV.). Therefore, this value of p gives the smallest amount of coal that can possibly be raised at a time to maintain the given output, P, in the given time, T.

We see by the equation (1), that the speed V_{max} does not vary proportionately to the load raised each time, but along the arc of the hyperbola represented by the same equation (1). Now, the size and output of the engine must be calculated to overcome an effort proportionate to $V_{max} \times p$, therefore it is much better to wind relatively heavy loads at slow speeds than otherwise, as thereby the diagram is better and the efficiency greatly increased. In other words, if 1000 tons must be wound in 8 hours by ropes of 3 tons from a given depth, and if the speed varied in an inverse ratio to the weight lifted per wind, to wind the same amount by ropes of 6 tons, the same power exactly would be required (the weight is double but the speed need only be half that in the former case). But this is not the case, as the engine in the first instance will have to develop all through the wind a much greater power than in the second, the steam-consumption for the same horsepower on the rope being also greater, as the work is done on a less favourable diagram.

Therefore, from a dynamical point of view, heavy lifts at slow speeds are always to be favoured. But here a limit has to be kept, as the bigger the lift the larger the size of engine, rope, drums, etc., so that the designer must choose a proper medium, compatible with a good dynamical efficiency, at the same time keeping the size and cost of the plant within reasonable limits.

This matter can be made clear by a practical example: Let us assume that we have to wind 1,000 tons in 500 minutes from 700 metres or 766 yards. To simplify things, let us take j equal to 1 and K equal to 10 (or 10 seconds allowed for decking 1 ton of coal). The maximum value of p is:—

$$p = \sqrt{\frac{20 \times 700}{6 \times 400}} = 2{\cdot}4 \text{ tons.}$$

This is the smallest amount of coal that can possibly be raised at a time, if we want our full output in the time stated.

The speed, V_{max}, would then be equal to 29 metres per second. The diagram is one great peak of about 2,500 horsepower. As can easily be imagined, the working is uneconomical, although the amount of coal can be raised in the time stated.

If we now choose a 4½ tons lift, the speed need be but 9·5 metres per second, this allowing 45 seconds for decking. The horsepower at full run is 700 horsepower, with a 1,300 horsepower-peak. With a 6 tons lift, we obtain 6 metres per second as the maximum speed, and, therefore, a 600 horsepower engine with a 1,200 horsepower-peak. In this case, a 4½ tons lift would be very suitable. This is simply mentioned in order to explain a fact that has struck many engineers when visiting Continental mines where the winding speed is not so great as that which they are accustomed to see over here. This way of considering things is perfectly accurate, at least from a theoretical point of view.

Another factor to be considered is the inertia of the whole system. We must store up an amount of energy in the system proportionate to the total mass and to the square of V_{max}: as it is difficult to recuperate effectively this energy at the end of the wind it is absolutely imperative that we should try and reduce these two factors, especially V_{max}, as even should M be twice as great, with $\frac{V_{max}}{2}$, the kinetic energy is only $\frac{V^2_{max}}{+} \times M \times 2 = \frac{V_{max}}{2} M$ or half that with a small lift. We lose less time in accelerating, and can obtain a smaller peak-load, the efficiency being thus greatly benefited.

If we consider now the cycle of a winding-engine, we see that in starting we have first to overcome the torque due to the load,

and then to accumulate energy in the masses to put them in motion: the actual work done by the load during this period is out of proportion with the energy spent, and we obtain a peak the summit of which is reached with the full speed.

Once full speed is reached, we have but to overcome the effo due to the load: if the dead weight is balanced, this effort is con stant, and the output of the engine also. When the cage is nearin the surface we have to retard, in other words cut off steam, an finish the wind by allowing the kinetic energy of the masses drive the engine.

If we consider an ideal engine with no friction whatever, a the energy produced finds its equivalent in work done by the load the efficiency being equal to unity. But, as a rule, we cannot recuperate all the energy of the masses (although this can be ver nearly realized by an electric winding-engine, as we shall see later on), on account of the long time that it would take to retard, so pa only is utilized, the other being absorbed by the brakes, counter steam, etc. Therefore, even if the friction-losses are *nil*, the kinet efficiency is inferior to unity: it is equal to about 0·85. The wor done by the load divided by the energy spent, being equal to 0·8 if we take a speed, $V_{max.}$, of 28 metres per second. With an electr engine, as all the kinetic energy is recuperated (*minus* trans formation-losses), the kinetic efficiency is about 0·95 under th same conditions. This is one important factor in favour of th electric winding-engine.

Compensating Devices.

Before going any further, it will be necessary to examine a mo important question so far as winding-engines are concerned, namel the compensating or equalization of the load on a motor or seri of motors having work of an irregular kind to perform. Th winding-engine can be taken as a type, although the same co siderations apply indiscriminately to any other kind of work this description, such as rolling-mills, tramways, etc.

If we consider the interval that elapses between the beginni of two winds, we notice that during this period (or cycle) th energy absorbed by the engine at two different moments is by means the same. Nevertheless, each time, the total amount power spent is constant for every cycle. If P be the weig lifted, and r the depth of the shaft, then Pr is the work done

the load: if η be the efficiency, then $Pr \div \eta$ represents the work done by the winding-engine itself.

If T seconds elapse between the time when we start raising the coal and the time when all is raised, the power expended or work done per unit of time would be $Pr \div \eta T$. Thus, the work done can be shown graphically by a rectangle, the base of which is equal to the total time, T, and the side to $Pr \div \eta T$ (Fig. 2, Plate IV.). The surface of this rectangle is equal therefore to the sum of all the surfaces contained in the total number of cycles that occur during the time, T.

Compensation amounts consequently to the following problem:—Given a work to perform that can only possibly be realized by making the engine work in an intermittent and irregular manner, find a device by means of which the demand on the generating plant is constant, whatever the instantaneous load may be (positive, negative or neutral), this demand being equal to $Pr \div \eta T$, η being the all-round efficiency.

Should we be able to realize this, then it is obvious that a winding-engine, rolling-mill, or other similar machine can, so far as the power-generating plant is concerned, be considered as a motor of constant output corresponding to the instantaneous values of the load equalized over the whole working period.

One method that has in some instances been successfully employed consists in placing a storage-battery in parallel with the winding-motor. The arrangement is as follows:—The dynamo feeding the winding-engine is, as we have already explained, calculated for the equalized load, it is connected directly to the winding-motor, and a storage-battery is shunted across the terminals (Fig. 3, Plate IV.).

When the call of the winding-engine for energy exceeds the constant output of the dynamo, the battery is made to discharge itself into the motor, so that the output of the dynamo and the output of the battery is equal to the output of the winding-motor. If the output of the winding-motor is equal to or greater than the output of the dynamo and the output of the battery, the dynamo is loading the battery, together with the winding-motor which has become a generator (electrical brakage of engine).

Several winding-engines are actually running on this system. Amongst others, the plant at the Thiederhall salt-mine, near

Brunswick, since August, 1899. The peak-load of this engine is equal to 200 horsepower. To drive the same, however, all that is in use is a 65 kilowatts belt-driven dynamo. The above is, let it be noted, a real winding-engine, having a Government permission to wind the men employed in the mine.

The only drawback to this arrangement is the cost of the battery, and the heavy insurance that has to be paid yearly for its upkeep.

But it has undoubted advantages, as the above figures show. For assuming that, all losses considered, a 200 horsepower motor needs a 180 kilowatts dynamo to feed it, should a direct drive be used, we would have to erect a 120 kilowatts dynamo with a 180 brake-horsepower engine, having 50 per cent. of overload-capacity. The primary plant would be cheaper perhaps (the battery disappearing), but the steam-consumption would be high, the steam-engine having to work on a very irregular diagram. The diagrams taken on the cylinder of the steam-engine at the Thiederhall salt-mine showed a line very slightly undulating, although practically horizontal in direction.

But it is only possible to use a storage-battery in conjunction with direct current; on the other hand, alternating current is coming very largely into favour, so that should we think it advisable to generalize the system, other methods must be used.

The writer would, therefore, like to bring before the members the following compensating devices, which are adaptable in every case.

(1) *The Station generates Direct Current.*—Let us consider an ordinary direct-current machine, whose armature-turns equal n, and whose field-intensity equals F. Running at N revolutions per second, this machine will develop an electromotive force equal to $nNF10^{-8}$ volts at the brushes. This occurs either when the machine is being driven mechanically or is running as a motor: in this case we call the electromotive force "counter-electromotive force." Now if the terminals of a similar machine are connected to a net, the voltage of which is constant and equal to E, and the same left to run as a motor, it will develop a counter-electromotive force $(E - IR)$ equal to $nNF10^{-8}$, I being the current inside the armature and R the resistance of the same.

Now, supposing we strengthen the field, F, so that it becomes $F + f$, but keep N constant, an extra voltage, e, equal to

$nNf10^{-8}$, is induced. If e equals IR, then the machine is neither receiving nor giving up current; and if e be greater than IR, it is running at a higher voltage than the net, and therefore feeding the same. If the field is weakened, then the opposite phenomenon occurs: the machine has a tendency to absorb more current.

Therefore, the writer proposes to equip such a machine with a flywheel of sufficient inertia and branch it on to a net, in parallel with the motor, whose load we wish to equalize (Fig. 4, Plate IV.).

The machine is running at its maximum speed, and the motor is starting. In the leads coming from the power-house, we place an apparatus very similar in principle to an ordinary ammeter, which closes two different relay circuits if the current has a tendency to rise above or below the value fixed for the equalized load. When the machine is started, it will of course have a tendency to increase, therefore one relay will be closed, thus bringing into action a magnetic clutch which takes out resistance from the field-circuit of the compensating machine: this operation, as we see, causes the machine to act as dynamo until the speed N_1 has been reached, so that E_1 equals $E-IR$ equals $nN_1F_110^{-8}$ equals $nNF10^{-8}$, and the flywheel by this drop in speed will have lost an amount of energy corresponding to $\frac{1}{2} M (N^2 - N_1^2)$, which is sent into the net as electric energy. The action of the clutch ceases as soon as the overload is off. If we have an underload, then the clutch draws in resistance into the shunt-circuit, while the machine absorbs the excess-current and stores the energy produced in the flywheel.

At any moment we have, exactly as in the case of a storage-battery:—The output of the winding-motor is equal to the output of the compensor and the output of the dynamo.

The field of the motor can be regulated without difficulty or the slightest inconvenience within fairly large limits (about 50 per cent.), so that the flywheel-effect can be calculated for a drop in speed varying from 45 to 50 per cent. at least (the rest being used to meet the armature-reaction, increased ohmic losses, etc.).

Should alternating current be used instead of direct current, the problem can be solved just as readily. In this case, however, the writer proposes to use as a compensating machine an alternating-current machine of the commutator-type, receiving current both in the stator and in the rotor.

As Mr. Latour, who has given a complete theory of this type of machine, points out, the speed of a similar arrangement is equal to :—

$$N_1 = \frac{N}{p} \frac{(n_r - n_s)}{n_r} \text{ at no load,}$$

n_r and n_s being the number of windings on the rotor and stator, N the frequency of the current, and p the number of poles per phase : n_r being greater than n_s (this is essential).

If we run the machine at a speed superior to N_1, it will be acting as a generator and sending current into the net.

Therefore by increasing n_s (by means of a transformer), the machine will have a tendency to run at a speed, N_2, greater than N_1, and until this latter speed is reached the machine is feeding the net.

Thus, by allowing a gradual drop of speed, from N_1 to 0·7 N_1, and by equipping the machine with a sufficiently heavy flywheel, the arrangement can be made to compensate any load imaginable. The inserting and disinserting of the transformer sections is done automatically, as the load varies.

We can take an elementary case to elucidate the above.

Let us assume that the diagram of a winding-engine is as shewn in Fig. 6 (Plate IV.). The power used is equal to (12,000 + 12,000 or) 24,000 horsepower-seconds. The equalized load is therefore (24,000 ÷ 66 or), 363 horsepower. If 0·8 be the efficiency of transformation, the compensor will have to consist of a (363 ÷ 0·8 or) 450 horsepower machine.

Let the speed of the same vary from 700 to 500 revolutions per minute, to compensate completely the above load all that is needed is a 9 tons steel flywheel of about 6 feet diameter of gyration.

Assuming that the efficiency of the compensating set is equal to 0·9, then 13,000 horsepower-seconds are sent into the net from the same, 11,000 horsepower-seconds are coming from the dynamos in the power-house, completing thus the 24,000 horsepower-seconds needed for each wind.

The purchase cost of such an arrangement is low, as the compensating motor can run at as high a speed as can be desired, and the slip or variation in turns can be also high; as the efficiency is in no way modified by this factor.

Besides this, we have the Ilgner compensating device, the essential feature of which is a motor-generator equipped with a heavy flywheel, inserted between the winding-motor and the feeding main. Mr. Ilgner keeps the load on the latter constant by automatically varying a resistance in the rotor-circuit of the motor driving the flywheel set. This brings about a slip or decrease in speed: the flywheel therefore abandons a certain amount of energy which, added to that provided by the motor, is equal to the momentary demand of the winding-engine. In this case, however, we note that all the energy utilized by the winding-motor is transformed instead of only a portion of the same, as in the previous case, this disadvantage being more than compensated for by the fact that it is possible to start the machine economically (Ward-Leonard) and to recuperate part of the kinetic energy stored in the masses whilst retarding.

Considerations on Starting of Electric Winding-engines, etc.

We come now to this most important question, and will consider in detail the losses that occur owing to this fact, and how these can be in some instances reduced considerably.

The three main factors in this study are (1) the value of the masses in motion, (2) the maximum speed to be reached, and (3) the acceleration chosen.

If we use one motor connected to the mains and an ordinary starting resistance, we see that the amount of energy taken from the mains is constant during the time that the machine is being started, and proportionate to the torque required. Thus, if in starting we need a torque corresponding to 1,500 horsepower, at full speed, the energy or power taken from the main is equal to 1,500 horsepower, while the output or work done by the motor is but equal to $1{,}500 \times \frac{1}{2} \times 15$ (the speed varying between zero and full). So that the losses each time are equal to $\frac{1}{2} \times 1{,}500 \times 15$, or half the rectangle ABCD or 11,250 horsepower-seconds (Fig. 7, Plate IV.).

Let M be the masses in motion, v the maximum speed, and j the acceleration per second chosen.

The energy taken from the mains is used for two purposes:—(1) A portion equal to $\frac{1}{2} Mv^2$ is stored in the masses in motion (drums, ropes, pulleys, cages, etc.). (2) A portion equal to $mgv^2 \div 2j\eta$ (mg or weight of coal, and η or efficiency), to cover the

work done by the load during the acceleration-period. (3) A portion equal to (1) + (2) is absorbed in the starting resistance, as we have just seen. The loss is therefore :—

$\frac{1}{2}Mv^2 + mg\frac{v^2}{2j\eta}$ with one motor; and

$2\left(\frac{1}{2}M\frac{v^2}{4} + mg\frac{v^2}{4\times 2j\eta}\right) = \frac{1}{2}\left(\frac{1}{2}Mv^2 + mg\frac{v^2}{2j\eta}\right)$ with 2 motors (series-parallel combination) and so on (Fig. 8, Plate IV.).

We have therefore the equation :—

$$\text{Losses} = \frac{1}{2}Mv^2 + mg\frac{v^2}{2j\eta}.$$

This equation, taken as a function of j (acceleration chosen), represents a hyperbola, the asymptotes of which are parallel to the axis and the centre of which is the point :—

$$j = 0, L_1 = \frac{Mv^2}{2};$$

for j equals ∞, the losses are equal to $Mv^2 \div 2$, and as j approaches 0, the losses follow the branch of the hyperbola, becoming infinitely great as j becomes infinitely small (Fig. 9, Plate IV.).

We see, therefore, that it is in our own interest to accelerate as quickly as possible, the quicker the better, as far as efficiency is concerned. We are, however, limited in this respect by the overload-capacity of the motor. As a rule, j should never exceed 1 metre (3 feet 3 inches) per second, and it is often chosen inferior to this value, if the masses in motion and the maximum speed are considerable.

This does away with the impression which some people have that a rapid acceleration means large rheostatic losses: in reality, it is the contrary that happens.

We see besides that the losses vary with the square of v and proportionately to M, and this is another very good reason to adopt slow speeds and heavy lifts. Thus, if by adopting a lift equal to 2 M, we can reduce v to $v \div 2$, the losses will have become $2 \div 4$, or half as great.

In conjunction with these remarks, the question of course arises, how is it possible to reduce those losses that occur each time in starting?

Continuous current offers us in this respect invaluable advantages over alternating current, at least if we consider but the ordinary type of induction-motor.

If we use one motor, then we can excite the coils of the same to complete saturation; if v be the speed of this motor when the coils receive their normal excitation, then the maximum speed in this case will vary from 0·75 to 0·80v. With a starting resistance, we reach this lower speed limit, then by bringing the field from saturation to its normal value (this occurs without loss) the speed is raised to its full value, v. The rheostatic losses are but 0·56 to 0·64 of those that would occur otherwise.

By using two motors and a tandem parallel arrangement, the losses are reduced exactly by one-half.

By using a storage buffer-battery (Zollern II.), the same can be subdivided into a certain number of sections, let us say 5. By branching the motors on to one after another of these subdivisions in succession, the losses that will then occur will equal $5 \div 25$ or $1 \div 5$ of those should no special arrangement be used. This method has some disadvantages, which lie in the fact that the terminals of the battery must be inverted at each wind, otherwise the first cells, being longer in circuit, would be sooner exhausted than the last ones. So that by numbering the sections, counting from left to right, 1, 2, 3, 4 and 5, and by starting the machine in the above order, for the next wind we shall have to use the sections in the succession 5, 4, 3, 2 and 1. It is necessary, therefore, to equip the arrangement with a complicated commutator to this effect.

Another method that could very well be used would consist in, let us say, an arrangement of two double-wound machines, each having two commutators.

If M is the winding motor, one of its terminals is connected to the net, and the other, by means of the switches 1, 2 and 3, to the different sections of the system. Let us suppose that we have 500 volts between the outer wires (1 and 5), between 5 and 4 we have 125 volts, and between 4 and 3, the same (Fig 5, Plate IV.). Consequently, by closing the switches in succession we increase the voltage by 125 volts each time, and the speed in the same proportion. The compensation of the load occurs (as before) by acting on the field. The losses are a fourth of those that would occur should ordinary arrangements be used. We need by no means invert the terminals as in the battery, and we can run at four different speeds by leaving the motor on one or more of the subdivisions.

If we use alternating current, the case does not look very brilliant, at least not for the present. With three-phase induction-motors we can by means of a cascade arrangement reduce the losses in starting by 50 per cent.: but that is all; anything further is not to be looked forward to with this type of motor.

If we use a multiphase motor with commutator and brushes, we could start without loss whatever (transformer), but for large slow-speed motors this type will be too costly (thus for 25 periods, 1,000 horsepower-output, 60 revolutions, the commutator would be about 14 feet in diameter and receive 2,500 segments). For a higher speed (geared arrangement) the method is not only possible but offers a very great opening to this type of machine.

In all the foregoing considerations it has been implicitly assumed that the dead weights are perfectly balanced, which implies the use of a balance-rope should no special type of winding be used. Should this not be the case, the problem assumes a different aspect, as the losses can then become much greater (50 per cent. and more) than before, according to the inequalities in the dead weights on each side in starting. But as it is always possible in any case to use a balance-rope, we can consider the discarding of such as a personal fancy and assume that, at least as far as an electric engine is concerned, the latter is always present.

There are certain other methods, such as the Ward-Leonard, that do away with a starting rheostat. This method, however, needs a conversion of electric energy at a constant voltage to electric energy at a variable voltage, this being brought about by means of a motor-generator set.

Now, in the Ilgner process this set is essential, so that it at once occurs to us to use the Ward-Leonard process instead of a starting resistance. We can thus compensate in a certain measure the conversion-loss.

We will therefore now examine the question, What arrangement is to be preferred from a purely economical point of view—one using a starting resistance or a voltage-converter?

To answer this point fully, we will assume that we have to raise P tons of coal from a depth equal to r metres; let p be the net weight of coal raised each wind.

Winding-engine with one Motor and Starting Resistance (Preussen II. Type).—The number of winds to be made is equal to $P \div p$.

The total rheostatic losses that occur are equal to:—

$$\left(\tfrac{1}{2}\,\frac{Mv^2}{\eta} + \frac{pv^2}{2j\eta_1}\right)\frac{P}{p}, \quad \ldots\ldots\ldots \quad (\alpha)$$

M being the total mass in motion at each wind, η the efficiency of the armature, and η_1 of the motor and winding-engine. Let it be noted that v is given by equation (1).

The losses in the motor and winding-engine are:—

$$\frac{Pr}{\eta_1} - Pr.$$

For acceleration-loss (kinetic energy that cannot be recuperated), we take:—

$$0{\cdot}2\,\frac{Mv^2P}{2p}.$$

With an Ilgner arrangement, these losses are equal to:—

$$\frac{Pr}{\eta_1\eta_3} - Pr \quad \ldots\ldots\ldots \quad (\beta)$$

η_1 being the efficiency of the motor and the winding-engine, and η_3 the efficiency of the compensating set.

Let us consider the function $f(v) = (\alpha) - (\beta)$.

$$y = \tfrac{1}{2}\,v^2\left(\frac{M}{\eta} + 0{\cdot}2\,M + \frac{p}{j\eta_1}\right)\frac{P}{p} - Pr\left(\frac{1}{\eta_1\eta_3} - \frac{1}{\eta_1}\right).$$

This equation in v represents a parabola (Fig. 10, Plate IV.). The summit of this curve being in $A\left(o, -Pr\left(\frac{1}{\eta_1\eta_3} - \frac{1}{\eta_1}\right)\right)$. If y is greater than o, then an Ilgner set is more efficient. If y is less than o, a rheostat. If y equals o, then both are equivalent. In this case (y equals o):—

$$v = \sqrt{\frac{r\left(\frac{1}{\eta_1\eta_3} - \frac{1}{\eta_1}\right)}{\frac{1}{2p}\left(\frac{M}{\eta} + 0{\cdot}2\,M + \frac{p}{j\eta_1}\right)}}.$$

Thus we can assume, η_1 equals 0·72, η_3 equals 0·75 (allowing for a variable extra slip of 0 to 10 per cent.). Now, with a properly-designed engine, the writer has found that the ratio between the total masses in motion and the net load varies between 10 and 15, according to the depth, and if a Kœpe or cylindrical drum, etc., be in use, a direct-current machine having a small momentum of inertia gives a lower value than an induction-motor, all things otherwise being equal.

We can therefore assume that $Mg \div p$ equals 15 or M equals $15p \div g$, therefore :—

$$v = \sqrt{\frac{r\left(\frac{1}{\eta_1\eta_3} - \frac{1}{\eta_1}\right)}{\frac{1}{2}\left(\frac{15}{\eta g} + \frac{0{\cdot}2 \times 15}{g} + \frac{1}{j\eta_1}\right)}}.$$

In the above case, we see that, if we do not want to have a starting torque more than 80 per cent. greater than the normal one, the acceleration j must be taken equal to $0{\cdot}8g \div 15\eta$, as η equals $0{\cdot}8$, j equals $g \div 15$ equals 0·7 metre per second in round figures, and g equals 9·81 metres per second.

We can now, by giving to r different values from 100 metres onward, obtain different values of v, which will correspond to the limit at which both systems are equivalent. The following table refers to this.

Depth, r.		Velocity, v.	Depth, r.		Velocity, v.	Depth, r.		Velocity, v.
Metres.	Yards.	Metres per second.	Metres.	Yards.	Metres per second.	Metres.	Yards.	Metres per second.
100	110	4·86	400	440	9·70	700	770	12·80
200	220	6·72	500	550	10·80	800	880	13·70
300	330	8·45	600	660	11·80	1,000	1,100	15·40

All these points lie on a curve whose equation is v^2 equals $0{\cdot}235\ r$. It is easy to see that the same is a parabola (Fig. 11, Plate IV.), whose focus is the point (v equals 0, r_1 equals 0·0587). This parabola divides the plane into two regions; we call positive, the portion inside the parabola: negative, the one outside the same. Therefore, for a point in the positive region it is more advantageous to use a starting resistance, and for one in the negative an Ilgner arrangement.

Let it be noted that, if the standard output of fuel per hour is known, v is a fixed quantity, so that in each case we obtain a definite position for the point in question. There is nothing arbitrary about it.

Of course, should we prefer to use a combination of two motors, these figures would be increased, but as a rule with a direct drive (three-phase) one motor is generally used, so that it is not always correct to assume that so far as general efficiency is concerned, the Ilgner process must have an advantage over the other: this is only the case if the speed exceeds a certain limit.

But, apart from trying to reduce as much as possible losses due to starting, we must not forget that another point is quite as (if not more) important, namely, that of keeping the load as constant as possible on the steam-engines driving the generating plant.

Should we not think it advisable to work on similar lines, then it is obvious that the steam-engines and generators will have to be so calculated as to be able to take up all overloads regularly and without any undue strain (considering just now the fact that the winding-engine is the only load on the steam-engine).

The flywheels will have to be of a considerable moment of inertia, for the following reason:—When the winding-engine is at rest, the engines are running with a very reduced steam-admission, when the overload is suddenly placed on the same, it is evident that before the regulator can have had time to operate properly a certain number of piston-strokes will have been made, there will be a certain drop in speed, and the flywheels will have to be calculated in such a manner that, in conjunction with the more or less sensitive regulators, this drop should be reduced to a minimum: in other words, they must be able to take up the load while the steam-engines are regulating.

We can easily imagine that the steam-consumption of even a good engine in these conditions will be anything but favourable. It is, however, only right to say that the matter presents quite a different aspect if we have two or three winding-engines running at once and a steady motor-load of fans, pumps, etc., besides. This is the more general case that we have to consider.

If we now erect a single, or at the most two, generating units sufficient to feed all the machines together, the arrangement will no doubt work in a satisfactory manner.

For that it is advisable that the peak-load of a winding-engine should not exceed, let us say, 40 per cent. of the total capacity of the engines.

Let us suppose that we have three winding-engines having each a 1,500 horsepower-peak and 800 horsepower normal load, 800 horsepower in fans, pumps, etc.

We choose either one 3,000 kilowatts set or two 1,500 kilowatts sets to deal with this load. At a given moment, two winding-engines are absorbing 1,600 horsepower, and the fans, pumps, etc.,

800 horsepower. If we now start the third engine, the load on the engines will become equal to 3,900 horsepower, instead of 2,400 horsepower as immediately before. The engines can easily take up the overload.

If such a large unit absorbs, let us assume, 5 kilogrammes of steam per indicated horsepower, running at constant admission, experiments have proved that under the above conditions the consumption will increase to 6 or 6½ kilogrammes, or 20 to 30 per cent. Therefore, technically speaking, the arrangement is possible if we have a large colliery to deal with, and if the question of first cost is an essential factor.

If an Ilgner arrangement be now used, the first item that disappears is the starting resistance: this fact alone is an immense advantage (efficiency apart), for a really reliable and simple starting arrangement for large motors working in an intermittent manner has yet to be designed. The starter is the weak part of the direct method, and the portion of the installation that gives the most trouble, in conjunction, of course, with the switch for the main current.

By driving our electric winding-engines by the indirect method, a load of constant magnitude is placed on the power-station, the generating-plant is smaller and works much more efficiently.

Thus the three winding-engines examined previously could be run with three 450 to 500 horsepower sets, giving a 1,350 horsepower total load. Instead of a 3,000 kilowatts set, all that would be needed is a 2,000 kilowatts set. The price of the primary station will thus be reduced as well as the coal-bill, the engines running under better conditions.

The only drawback offered by the Ilgner system is its relatively high cost, if we compare it with the ordinary type of twin cylinder winding-engine generally in use. The costs are 25 to 30 per cent. greater, but are about the same if we take a tandem compound twin winding-engine, which is undoubtedly the best type of steam winding-engine.

The question of first cost intimidates in a large measure most people, especially when they have but one or two winding-engines to erect, and need very little power besides that. The pits, and consequently the machinery, are all very close together, so that apparently it would seem as if but very minor advantages would be reaped should we electrify the whole installation, at least so far as economy on paper is concerned.

To meet the above objection, which can easily be repudiated, the writer would propose the following solution, which overcomes the difficulty in both ways.

Assuming, to make everything quite clear, that we have, let us say, two winding-engines to erect, the distance between the same being about 1,800 to 2,400 feet, which means from 900 to 1,200 feet from the power-station placed midway between the two pits.

As a rule, in British pits, the winding-engines are at work during one shift only (day-shift), which means from 8 to 10 hours a day; the other machinery in the mine, such as fans, pumps, etc., runs the whole day and night through. Therefore, *a priori*, it is advisable, in any case, to have one set of engines to feed the winding-plant and another for the fans, pumps, etc.: this to ensure a good efficiency, the engines working at their most favourable grade of admission.

What the writer proposes doing would be to use in any case direct current to drive the winding-engines, even if three-phase current is used for the other plant: further, one dynamo per winding-engine. These dynamos can either be driven by separate engines or by one only. The regulator of this engine is arranged so that the steam-admission into the cylinders remains constant, whatever the speed of the engine may be between the two speed-limits, V_1 and V_2. The thrust or effort is therefore constant during this interval, or, to fix a figure, between 350 and 315 revolutions per minute. Should now the speed increase above 350 revolutions, then the regulator cuts off steam and keeps the engine at the superior speed-limit, preventing it thus from racing. It can also be made to admit more steam if the speed should have a tendency to drop below V_2 (315 revolutions).

On the shaft of this steam-engine, a steel flywheel, similar in every respect to those used with the Ilgner sets, is fixed. If such a flywheel weighs 30 tons, and the peripheral speed be 270 feet per second, then by dropping from 350 to 315 revolutions, the kinetic energy abandoned will equal 24,000 horsepower-seconds, which add themselves to the constant output that the steam-engine is giving during this drop in speed.

Let us take an example:—We have to raise 1,000 tons in 8 hours from a pit 760 yards deep, the net weight raised each time being equal to 4½ tons. If the efficiency of the winding-engine is

0·8, that of the motor 0·9, transmission-line and dynamo 0·85, then the number of horsepower-seconds to be produced by the steam-engine will be equal to 72,600 brake-horsepower, allowing 4,800 horsepower-seconds for loss in the bearings supporting the flywheel. As the interval between 2 winds is equal to 120 seconds, the equalized effort is therefore equal to 600 horsepower. The weight of the flywheel is 36 tons.

When the winding-engine is at work, we obtain a peak-load of about 1,800 horsepower, which drops down to about 1,000 horsepower during the run. The steam-engine, owing to the steam-admission being constant, works at a constant effort or thrust. Should the load be superior to this value (600 horsepower), the steam-engine will drop in speed, and in doing so the flywheel will give up an amount of energy, which, added to the output of the engine, meets automatically any instantaneous or momentary overload of really considerable magnitude.

When the winding-engine is at rest, then the steam-engine will be gathering up speed, energy being thus stored in the flywheel. Should there be a longer period of rest, such as an unforeseen stoppage, for instance, then once the higher speed-limit of the engine is reached, the steam is automatically shut off, keeping the engine running at a constant speed.

Let us note once for all that the governing of the winding-engine is in everything identical to that used with an Ilgner gear, this method being known as the Ward-Leonard.

The purchase-costs of such a plant are unquestionably very low; they will in all probability turn out inferior to that of an ordinary steam winding-engine, and will be much below that of a tandem compound winding-engine. In the above case, that is to say, the complete winding-plant, including boiler, steam-piping, steam-engine, dynamo, winding-engine and motor, cabling, switch-board, and all accessories, would entail an expenditure of £8,000.

A complete steam winding-plant of that capacity with boilers, etc., could hardly be had for that price.

So far as steam-consumption is concerned, as we can use superheat and condense, the coal-consumption would be equal to 4½ tons for 1,000 tons raised, assuming that 1 pound of coal produces 7½ pounds of steam. The writer would be prepared to guarantee 6½ tons any day and under any penalty. Of course, should we wind from half the depth or 380 yards, then all that is needed is a 310 horsepower plant: the costs would be

much reduced, and the coal-consumption would become equal to 2·6 tons, as the thermal efficiency of a 310 horsepower engine is, as a rule, worse than that of a 620 horsepower. With the Ilgner system these coal-consumption figures must be increased by 20 per cent. to meet the losses in the motor-generator.

It must also not be forgotten that the application of the above system is not so general as the Ilgner process, which is adaptable under any circumstances whatever.

Recuperation of the Energy Stored in the Moving Mass.

Let us consider all the moving parts of a winding-engine, such as drums, ropes, cages, motor, etc. Let M be the mass of the same reduced to a common radius of gyration, that of the drums for instance.

If v be the speed per second during the full run, then to bring this system to rest we must absorb in some way or other $\frac{1}{2} Mv^2$ kilogrammetres. In practice, part of this is used to finish the wind and part absorbed in the brakes. Not to be too wasteful, we limit this latter quantity to 20 per cent. of $\frac{1}{2} Mv^2$.

The work done by the load, j being the chosen retardation, and P being the weight of coal, is $Pv^2 \div \eta 2j$.

Let η be the efficiency of the mechanical parts, etc., then we have the equation :—

$$\frac{Pv^2}{\eta 2j} = \frac{0{\cdot}8}{2} Mv^2; \text{ and } j = \frac{P}{0{\cdot}8M\eta}.$$

If we note that $\frac{P}{M} = \frac{m}{M} g = \frac{1}{\lambda} g$; if $\lambda = \frac{M}{m}$, then :—

$$j = \frac{g}{\lambda 0{\cdot}8\eta}.$$

The time, t, taken to retard is $v \div j$.

Thus, if M equals 6,000, P equals 4,500, v equals 20 metres per second, λ equals 13·4, and t equals 16 seconds. This is a very long time, and should we wish to retard faster, it must be at the cost of the general efficiency (absorbing a greater percentage of the kinetic energy).

We see, therefore, how great the advantage would be, if we could retard quickly and without any loss. This can be done with an electric winding-engine, in the following manner :— Let us consider the winding-engine running at full speed, and the winding-motor running with an electromotive force equal to

about 97 per cent. of that developed by the dynamo. If we weaken the field of the dynamo by drawing back the controller-lever, the following phenomenon occurs:—The winding-motor is running at a higher voltage than the dynamo, and is being driven by the masses in motion; a current therefore flows from the motor to the dynamo, and all the heavier, the quicker we draw back our controller-lever. The driving motor has become a generator, the driving engine of which is the kinetic energy of the masses, the energy recuperated is stored in the flywheel, as, while the electric brakage is going on, the dynamo is acting as a motor.

The losses incurred are those that take place inside the electrical machinery, and are constant.

The advantage of this arrangement is that we can retard as quickly as we like without fear of a bad efficiency, so we gain time and can make our wind in a shorter period.

At Zollern II., the coefficient j equals 2·5 metres per second, and here it is limited on account of the fear of the rope slipping, so that we can retard in 8 instead of 16 seconds. This is a very considerable gain.

The intensity of the brakage-current is easy to determine. The run is equal to 80 metres, the work done is (80 × 4,500 ÷ 0·8 or) 450,000 kilogrammetres. In the masses are stored (6,000 × 400 ÷ 2 or) 1,200,000 kilogrammetres.

Let 0·8 be the efficiency of conversion, then (750,000 × 0·8 ÷ 75 or) 8,000 horsepower-seconds are working on the flywheel shaft. As the time taken is equal to 8 seconds, the current in the armature is equal to 3,200 ampères at 500 volts.

A WINDING-ENGINE WITHOUT A BALANCE-ROPE (FIG. 12, PLATE IV.).

Let P be the net weight of coal raised at each wind, and p the friction-coefficient of the pit, engine, etc., which the writer considers as a fraction of P (p equals μP). Let r be the depth of the pit, and w the weight of the rope per unit of length.

In starting, the torque or effort to be overcome is composed of (1) the static torque $[P(1 + \mu) + rw]R$; (2) the torque necessary to overcome the pressure due to acceleration—the effort at a given moment, t, corresponding to:—

$\frac{d\frac{Mv^2}{2}}{dt}$-horsepower, or a torque $716 \times \frac{d\frac{Mv^2}{2}}{dt} \times \frac{1}{n}$: . . . (2)

n being the speed of the drums.

Torque during Acceleration.—During the acceleration-period, which lasts t_1 seconds, the run of the rope after t seconds (t_1 is greater than t and t is greater than 0) is equal to $\frac{1}{2}jt^2$, j being the acceleration; therefore the torque at a given moment will be:—

$$y = [P(1 + \mu) + (r - jt^2)w]R + (2).$$

This is the equation of a parabola.

To obtain the amount of power required, we must calculate:—

$$\left(\int_{t=t_1}^{t=o} [P(1 + \mu) + (r - jt^2)w] \frac{jt \times 60}{2\pi \times 716}\right) + \frac{1}{2}Mv^2.$$

This integral is equal to:—

$$\left(P(1 + \mu) + (r - jt_1^2)w\right)\frac{jt_1^2 \times 60}{4\pi \times 716} + \frac{j^2t_1^4w \times 60}{8\pi \times 716} + \frac{1}{2}Mv^2.$$

Run at Full Speed.—During the run at full speed, the torque, θ after t seconds is equal to:—

$$\theta = [P(1 + \mu) + (r - jt_1^2 - 2tv)w]R.$$

The amount of power required is equal to:—

$$\int_{t=t_2}^{t=o} \theta \frac{Rn}{716} dt = [P(1 + \mu)t_2 + (rt_2 - jt_1^2t_2 - t_2^2v)w]\frac{R \times n}{716}.$$

Retardation.—The kinetic energy contained in the masses is used for two purposes (1) to drive the load, enabling it thus to accomplish the journey; and (2) the surplus is sent back into the net in the shape of electric energy. The power needed by the engine during the retardation being at a moment t equal to:—

$$\frac{R \times n_1}{716}\left(P(1 + \mu) + (r - jt_1^2 - 2t_2^2v - j_1t^2)w\right)dt, \quad . \quad . \quad (5)$$

j_1 and n_1 being the retardation-coefficient and the speed of the drums at a given moment, respectively.

The total power needed during the retardation-period lasting t_3 seconds, if we call equation (5) θ_1, is:—

$$\int_{t=t_2}^{t=o} \theta_1 dt.$$

Solving we get:—

$$A = \left[P(1+\mu) + (r - jt_1^2 - 2t_2v - j_1t_3^2)w\right]\frac{j_1t_3^2 \times 60}{4\pi \times 716} + \frac{j_1^2t_3^4 \times 60w}{8\pi \times 716}.$$

If η is the transformation-efficiency, then the actual quantity of energy disposable in the system is equal to:—

$$\left(\frac{1}{2}Mv^2 - A\right)\eta.$$

Let us take a numerical example:—Let P be 4,000 kilogrammes; μ, 0·2; w, 10 kilogrammes per metre; r, 600 metres; v, 15 metres per second; j, 1; j_1, 2; M, 5,000; n, 60 revolutions per minute; R, 2·4; t_1, 15 seconds; t_2, 29 seconds; and t_3, 7·5 seconds.

Acceleration-period.—$(4{,}000 \times 1{\cdot}2 + 6{,}000)\frac{225 \times 60}{12{\cdot}6 \times 716} - \frac{50{,}625 \times 600}{25{\cdot}2 \times 716} + \frac{225 \times 5{,}000}{2 \times 75} = 22{,}020$ horsepower-seconds.

Run at Full Spred.—$(10{,}800 \times 29 - 2{,}250 \times 28 - 841 \times 150)\ 0{\cdot}201 = 24{,}200$ horsepower-seconds.

Retardation.—$(4{,}800 + (6{,}000 - 2{,}250 - 8{,}700 - 1{,}125)\ 0{\cdot}74 + \frac{3{,}158 \times 60 \times 10}{25{\cdot}2 \times 716} + 4 =$ minus 520 horsepower-seconds, and minus 7,500 equals minus 8,020 horsepower-seconds. Therefore, (8,020 × 0·8 or) 6,416 horsepower-seconds are effectively recuperated. The total wind needs, consequently (22,020 + 24,200 − 6,416 or), 39,884 horsepower-seconds.

As a point of comparison, the writer assumes that we use a balance-rope, all figures remaining otherwise the same.

During the acceleration-period, the power needed at each wind is equal to (980 × 15 or) 14,700 horsepower-seconds. During the run at full speed, the power required is (960 × 29 or) 27,840 horsepower-seconds. And in retarding, the load absorbs to finish the wind 3,600 horsepower-seconds. There remain (7,500 − 3,600 or) 3,900 horsepower-seconds disposable on the winding-engine shaft, or 3,100 on the motor-generator. The total power needed is therefore (14,700 + 27,840 − 3,100 or) 39,440 horsepower-seconds.

This is but slightly less than with an engine without balance-rope, the difference being about 1 per cent. This is easily to be accounted for by the fact that a greater quantity of power is recuperated without a balance than with one.

We see, therefore, that from a theoretical standpoint it is immaterial whether we use a balance-rope or not, as the power-station and motor-generator remain identically the same (the 1 per cent. difference being of no account). The driving motor for the

winding-engine has to be considerably larger, as the initial torque in starting is 50 per cent. greater than if we use a balance-rope. That is the only objection to be raised from a practical standpoint.

Should we now use a starting resistance with one motor on the winding-engine, it is easy to see that the case is hopeless from an economical point of view.

We lose in the starting resistance 22,020 horsepower-seconds, and cannot recuperate any energy at all in retarding. We cut off, however, sooner than before, to allow a longer retardation run, so that altogether the amount of energy absorbed per wind is equal to 62,500 horsepower-seconds in round figures, or 20 per cent. more than if a balance-rope were used, the consumption in this case being about 52,000 horsepower-seconds.

To sum up the situation, we have drawn up Table I. upon which the following remarks can be made:—The steam-consumption figures for the different types of steam winding-engines refer to the best of their kind, of first-class make with all modern improvements. The tandem compound engine is of the type used at the Scharnhorst pit, near Dortmund. This engine alone for 1,000 tons in 10 hours from 800 metres costs with seat over £8,500; so that one for 2,000 tons with boilers, piping, economizers, etc., would cost at least £14,000. The coal-consumption of such an engine is low, as compared with the steam winding-engine generally in use.

The figures given for a twin-cylinder engine are also favourable, and ought to be reached with an engine of good build and design.

It is, on the other hand, very easy to calculate the steam-consumption of an electric winding-engine, as innumerable tests have shown what a good modern steam-engine working under favourable conditions can give as regards steam-consumption. A triple-expansion engine or steam-turbine, with a moderate superheat, can easily be made to reach the figure of 12 pounds per brake-horsepower. This would give about 24 pounds per horsepower on the rope with an Ilgner arrangement, or 19 pounds if the author's device be used.

We can thus economize as much as 8,300 tons of coal a year or £2,500, if coal at 6s. a ton is used (working in both cases, non-condensing and without superheat).

The cost of an electric winding-plant complete, that is to say with generating-plant, boilers, steam-pipes, cables, compensating

TABLE I.—WINDING-ENGINE FOR 2,000 TONS IN 8 HOURS FROM 600 YARDS, OR 600,000 TONS A YEAR.

Nature of Winding-plant used.	Steam-pressure.	Steam-consumption per Horsepower on the Rope.				Coal-consumption per 300 Days, allowing 6 Pounds of Steam per Pound of Coal and 30 per cent. for Condensation in Pipes, Banking Fires, etc.				Cost of Purchase and Erection, including Seat, Engine and Accessories, Boilers, Economizers, Superheaters, Condensation-plant, Piping, Generating-dynamos and Engines, etc.
		Condensing without Superheat.	Non-condensing without Superheat.	Condensing with Superheat.	Non-condensing with Superheat.	Condensing without Superheat.	Non-condensing without Superheat.	Condensing with Superheat.	Non-condensing with Superheat.	
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Tons.	Tons.	Tons.	Tons.	£
Horizontal tandem compound four-cylinder engine ...	180	55	65	50	58	6,800	8,000	6,100	7,000	13,000
Twin-cylinder winding-engine	120	75	95	68	85	9,200	11,700	8,400	10,500	11,000
Electric winding-engine: Ilgner system	180	28	33½	23	30	3,500	4,100	3,000	3,700	14,800
Electric winding-engine: Georgi system	180	22	27	19	23	2,700	3,400	2,400	3,000	12,000

NOTE.—Should no balance-rope be used, the steam-consumption of the steam winding-engines will increase 10 to 15 per cent., while that of the electric engines remains unaltered.

, winding-motor, and all accessories would be £14,800. A am winding-engine with seat-accessories, boilers, etc., would dly cost less than £11,000. Therefore, as a matter of fact, the ference in price could be wiped off in the first year and the whole chine paid for at the end of 6 years, without the mine-owner ring had to devote a penny for depreciation or interest, purely of the saving brought about each year. The question of first t is quite subsidiary, for, in the above case, after 6 years the ctric winding-engine brings in an income of £2,000 a year and ires at 1s. in the books, the comparison being drawn with a d steam winding-engine.

Mr. M. H. Habershon said that, in the table attached to Georgi's paper, the steam-consumption per horsepower with Ilgner system was stated to be much lower than the figure d by Mr. Hird in his paper on "The Electrical Driving of nding-gears."* He believed that at that time the system was dly in full operation, and he should like to know whether ılts had been obtained in the interval which would justify the er figure now given of the steam-consumption.

Prof. G. R. Thompson suggested that the system of equaliz- the load of the winding-engine might be carried somewhat ther with the steam-engine.

Mr. W. E. Garforth (Normanton) said that Messrs. Pope l Pearson had recently made a careful test and raised 1,272 s from a depth of 1,020 feet in one shift, with a boiler-conmption of 6 tons 12 cwts.

Mr. W. H. Pickering asked what was the difference in the tter of depreciation between an electric and a steam wind-engine.

The President (Mr. T. W. H. Mitchell) pointed out that Mr. orgi approved of the use of direct current for winding-engines, t he had always understood that multiphase current was the eapest for that work.

Mr. Georgi explained that the steam-consumption in an elec- c winding-engine depended upon the primary plant, and

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 605.

upon the consumption per kilowatt. The consumption of co[illegible] in raising 1,272 tons would have been from 2 to 2½ tons wi[illegible] an electric winder; provided that a modern engine, with a lo[illegible] steam-consumption were used: Messrs. Carels & van den Kercho[illegible] guarantee a consumption not exceeding 8·8 pounds of steam p[illegible] indicated horsepower. The depreciation of steam and elect[illegible] plant was practically the same, as the mechanical portions w[illegible] almost identical.

Mr. I. HODGES stated that he had doubled his output fo[illegible] less consumption of coal by the winding-engine. He was c[illegible] vinced, however, that electric winders would be the windi[illegible] engines of the future. Engineers were convinced theoretica[illegible] and they only needed to be convinced practically.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

ANNUAL GENERAL MEETING,

HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE, AUGUST 6TH, 1904.

MR. W. O. WOOD, RETIRING PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on July 23rd and that day, and of the Council of The Institution of Mining Engineers.

ELECTION OF OFFICERS, 1904-1905.

The RETIRING PRESIDENT appointed Messrs. John Simpson, John Southern, Norman B. Ridley and W. B. Wilson, jun., as scrutineers of the balloting-papers for the election of officers for the year 1904-1905.

The SCRUTINEERS afterwards reported the result of the ballot, as follows:—

PRESIDENT:

Mr. T. W. BENSON.

VICE-PRESIDENTS:

Mr. R. DONALD BAIN.	Mr. T. Y. GREENER.	Mr. J. H. MERIVALE.
Mr. W. C. BLACKETT.	Mr. W. LOGAN.	Mr. M. W. PARRINGTON.

COUNCILLORS:

Mr. R. S. ANDERSON.	Mr. M. H. DOUGLAS.	Mr. J. H. NICHOLSON.
Mr. J. B. ATKINSON.	Mr. T. E. JOBLING.	Mr. HENRY PALMER.
Mr. R. W. BERKLEY.	Mr. PHILIP KIRKUP.	Mr. F. R. SIMPSON.
Mr. R. B. CLARK.	Mr. HENRY LAWRENCE.	Mr. JOHN SIMPSON.
Mr. FRANK COULSON.	Mr. C. C. LEACH.	Mr. R. F. SPENCE.
Mr. BENJAMIN DODD.	Mr. W. C. MOUNTAIN.	Mr. R. L. WEEKS.

The CHAIRMAN (Mr. W. O. Wood) moved a vote of thanks to the Scrutineers for their services.

Mr. M. WALTON BROWN seconded the resolution, which was cordially approved.

Mr. J. J. TURNBULL (Bengal) moved a vote of thanks to the Retiring President, Vice-Presidents and Councillors, and to the representatives of the Institute on the Council of The Institution of Mining Engineers for their services during the past year.

Mr. W. TAYLOR HESLOP (Natal) seconded the resolution, which was very cordially adopted.

The Annual Report of the Council was read as follows:—

ANNUAL REPORT OF THE COUNCIL, 1903-1904.

The Council have to deplore the death of Mr. William Cochrane, a past-president, who, at all times, took an active part in the affairs of the Institute. From its inception he took great interest in the Durham College of Science, and served upon the Council of the College for many years.

The following table shows the progress of the membership during the past few years:—

Year ending August 1st.	1902.	1903.	1904.
Honorary Members	25	26	26
Members	893	921	955
Associate Members	109	112	115
Associates	122	161	163
Students	66	69	66
Subscribers	23	23	25
Totals	1,238	1.312	1.350

The members are to be congratulated upon the increase in the membership of the Institute:—100 members of all classes have been added to the register during the past year, and, after allowing for losses by deaths, resignations, etc., there is a net increase of 38 members.

The Library has been maintained in an efficient condition during the year; the additions, by donation, exchange and purchase, include 327 bound volumes and 117 pamphlets, reports, etc., and the Library now contains about 9,948 volumes and 201 unbound pamphlets. A card-catalogue of the books, etc., contained in the Library renders them readily available for reference.

Members would render useful service to the profession, by presentations of books, reports, plans, etc., to the Institute to be preserved in the Library and available for reference.

The courses of lectures for colliery-engineers, engine-wrights and apprentice-mechanics have been continued at the Durham College of Science. The lectures are delivered on Saturday afternoons, and the three years' course embraces the following subjects:—

1904-1905. Michaelmas Term, (1) Theoretical Electricity, and (2) Electrical Engineering. Epiphany Term, (3) Steam-engines and Boilers, and (4) Haulage and Winding.

1905-1906. Michaelmas Term, (5) Transmission of Power, and (6) Pumping and Ventilation. Epiphany Term, (7) Metallurgy of Iron and Steel, and (8) Mining Machinery (mainly machinery used underground).

1906-1907. Michaelmas Term, (9) Mensuration, and (10) the Chemistry of Fuel. Epiphany Term, (11) Strength of Materials (with experimental illustrations), and (12) Experimental Mechanics.

Several colliery-owners have paid the fees (£1 10s. 0d. per annum) and railway expenses of pupils attending the classes from their collieries. During the past year, the lectures of the Michaelmas Term on Mensuration were attended by 25 students, and the Chemistry of Fuel by 28 students, 21 of these sat for examination and 19 passed; and during the Epiphany Term, the lectures on the Strength of Materials were attended by 26 students, and upon Experimental Mechanics by 24 students, 22 of these were examined and 19 passed. Certificates have been awarded to the following students, who have completed the three years' course:—Messrs. James Anderson, John Eskdale and Thomas S. Shevels. Mr. James Wright Collingwood, who gained the highest aggregate number of marks, has been awarded the prize for the session 1903-1904.

G. C. Greenwell bronze medals have been awarded to Mr. William Blakemore for his paper upon "The Fernie Explosion,"* to Dr. J. S. Haldane for his paper upon "Miners'

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 450.

Anæmia, or Ankylostomiasis,"* and to Mr. F. W. Hardwick for his paper upon "Underground Fires."†

Mr. Clarence R. Claghorn's prize of £10 for the best essay upon "The Action, Influence and Control of the Roof in Longwall Workings" has been awarded to Mr. H. W. G. Halbaum for his paper dealing with that subject.‡

The first *Report of the Committee upon Mechanical Coal-cutting*, containing a description of longwall machines, has been issued to the members, and the further report on machines suited for working other than longwall will be issued shortly.

The *Subject-matter Index of Mining, Mechanical and Metallurgical Literature* has been continued, and enables the members to refer to the papers in numerous technical publications.

The Council have decided to publish a supplementary volume to *An Account of the Strata in Northumberland and Durham, as proved by Borings and Sinkings*, and members are desired to send copies of any unpublished sections of strata in these counties, or their section-books, to the Secretary on loan. A small tracing from the 6 inches Ordnance Map, showing the position of any shaft or bore-hole, if not already fixed by previous publications, will greatly facilitate the work.

The degree of Bachelor of Science in Mining of the University of Durham and the Diploma in Mining of the Durham College of Science have been approved by the Secretary of State for the Home Department for the purposes of the Coal-mines Regulation Act (1887) Amendment Act, 1903.

Mr. John Daglish continues to represent the Institute as a governor of the Durham College of Science, which was jointly founded in 1871 by the University of Durham and the North of England Institute of Mining and Mechanical Engineers; and Mr. T. E. Forster, in conjunction with the President (Mr. W. O. Wood), represents the Institute on the Council.

The Rev. G. M. Capell will represent the Institute at the Conference of the Corresponding Societies of the British Association for the Advancement of Science, to be held in Cambridge, commencing on August 17th, 1904.

Mr. George May represents the Institute upon the Board of Directors of the Institute and Coal Trade Chambers Company, Limited.

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 643.

† *Ibid.*, page 724.

‡ *Ibid.*, 1904, vol. xxvii., page 205.

The representatives of the Institute upon the Council of The Institution of Mining Engineers during the past year were as follows:—Messrs. Wm. Armstrong, John Batey, T. W. Benson, Bennet H. Brough, W. Forster Brown, J. S. Burrows, John Daglish, T. E. Forster, Reginald Guthrie, T. E. Jobling, Philip Kirkup, C. C. Leach, William Logan, Henry Louis, J. H. Merivale, C. A. Moreing, John Morison, Henry Palmer, R. A. S. Redmayne, Henry Richardson, J. B. Simpson, A. L. Steavenson, John G. Weeks and Gardner F. Williams.

An International Engineering Congress will be held from October 3rd to 8th, 1904, in conjunction with the St. Louis Universal Exposition, under the auspices of the American Society of Civil Engineers. The Committee in charge extend a cordial invitation to the members of the North of England Institute of Mining and Mechanical Engineers to participate therein, either in person, or by written communications on any of the subjects which have been chosen for consideration.

The Members have also been invited to participate in an International Mining Congress, to be held in Liége in September, 1905.

An exchange of *Transactions* has been arranged, during the year, with the Canadian Society of Civil Engineers and the Sociedad de Ingenieros, Lima.

Prizes of books have been awarded to the writers of the following papers communicated to the members during the year 1902-1903:—

"Working a Thick Coal-seam in Bengal, India." By Mr. Thomas Adamson, M.I.M.E.

"The Use of Carboniferous Plants as Zonal Indices." By Mr. E. A. Newell Arber.

"Description of the Lead-ore Washing-plant at the Greenside Mines, Patterdale." By Mr. Wm. H. Borlase, M.I.M.E.

"The Gypsum of the Eden Valley." By Mr. D. Burns, M.I.M.E.

"Sinking by the Freezing Method at Washington, County Durham." By Mr. Mark Ford, M.I.M.E.

"Air-compression by Water-power: The Installation at the Belmont Gold-mine." By Mr. D. G. Kerr, M.I.M.E.

"The Occurrence of Gold in Great Britain and Ireland." By Mr. J. Malcolm Maclaren, M.I.M.E.

"Some of the Considerations affecting the Choice of Pumping Machinery." By Messrs. A. H. Meysey-Thompson, M.I.M.E., and H. Lupton.

"The Geology of the English Lake District." By Mr. J. Postlethwaite.

"The Utilization of Exhaust-steam by the Combined Application of Steam-accumulators and Condensing Turbines." By Prof. A Rateau, M.I.M.E.

"Hæmatite-deposits and Hæmatite-mining in West Cumberland." By Mr. W. E. Walker, M.I.M.E.

The papers printed in the *Transactions* during the year are as follows:—

"The Rock-slide at Frank, Alberta Territory, Canada." By Mr. W. M. Brewer, M.I.M.E.

"Memoir of the late William Cochrane." By Mr. Cecil A. Cochrane.

"Report of the Delegate to the Conference of Delegates of Corresponding Societies of the British Association for the Advancement of Science, Southport, 1903." By Mr. John Gerrard, M.I.M.E.

"The Action, Influence and Control of the Roof in Longwall Workings." By Mr. H. W. G. Halbaum, M.I.M.E.

"Some Silver-bearing Veins of Mexico." By Mr. Edward Halse, M.I.M.E.

"Notes on Mining in Ireland." By Mr. G. H. Kinahan.

"Notes of Electric Power applied to Winding in Main Shafts." By Mr. W. C. Mountain, M.I.M.E.

"An Improved Forced Method of Treatment of Low-grade Copper-ores." By Mr. J. J. Muir, M.I.M.E.

"The Adoption of a Balance-rope at Hylton Colliery." By Mr. T. E. Partington, Stud. I.M.E.

"Well-sinking in the Punjab." By Mr. Rob. R. Simpson, M.I.M.E.

"Bore-holes for Pumping Purposes." By Mr. Edward S. Wight, M.I.M.E.

"The Re-tubbing of the Middle Pit, Murton Colliery, 1903." By Mr. W. Wood, M.I.M.E.

The rooms of the Institute have been used during the year by the Surveyors' Institution.

Mr. THOMAS DOUGLAS, in moving the adoption of the Report of the Council, referred with regret to the loss which the Institute had sustained in the death of no less than twenty members during the year. He also drew attention to the small measure of support which the Institute received in subscriptions from colliery-owners, who derived considerable benefit from the papers and discussions.

Mr. J. B. SIMPSON seconded the resolution, which was unanimously agreed to.

The Report of the Finance Committee was read as follows:—

REPORT OF THE FINANCE COMMITTEE.

The Finance Committee submit herewith a statement of the ɔunts for the twelve months ending June 30th, 1904, duly ited.

The total receipts were £3,003 15s. 6d. Of this amount, £27 paid for life-composition in lieu of annual subscriptions, £72 13s. as subscriptions in advance, leaving £2,904 2s. 6d. he ordinary income of the year, compared with £2,739 17s. 2d. the previous year.

The total expenditure was £2,757 10s. 1d. as compared with 726 4s. 4d. in the previous year. During that year, how- r, there was exceptional outlay in connection with the altera- ıs to the Lecture Theatre and the Jubilee of the Institute. ring the current year, the further sum of £133 has been d in connection with the alterations and furnishing of the ture Theatre. An increased expenditure is shewn for print- , stationery, postages, etc., and the cost of the Library alogue, also in the contribution to The Institution of Mining gineers, due to the increased membership. From the figures wn above, it will be seen that the total income exceeded the enditure by £246 5s. 5d., and adding this to the balance in ıd at the beginning of the year, amounting to £169 7s. 10d., re is a sum of £415 13s. 3d. to carry forward.

The names of 34 persons have been struck off the member- p-list, in consequence of non-payment of subscriptions. The ount of subscriptions written off was £172 19s., of which 3 1s. was for sums due during the year ending June 30th, 04, and £86 18s. for amounts which had fallen due in previous ırs. Some proportion of this will no doubt be recovered by Solicitors, and will be credited in future years.

JOHN B. SIMPSON.

August 6th, 1904.

The RETIRING PRESIDENT (Mr. W. O. Wood) moved the adop- n of the Report of the Finance Committee.

Mr. J. B. SIMPSON seconded the resolution, which was animously adopted.

DR. THE TREASURER IN ACCOUNT WITH THE NORTH OF ENGLAND FOR THE YEAR ENDING

	£	s.	d.	£	s.	d.
June 30th, 1903.						
To Balance at Bankers	103	5	7			
„ „ in Treasurer's hands	61	9	6			
„ Outstanding Accounts due from Authors for Excerpts	4	12	9			
				169	7	10
June 30th, 1904.						
To Dividend of 7½ per cent. on 179 Shares of £20 each in the Institute and Coal-trade Chambers Company, Limited, for the Year ending June 30th, 1904 ...	£268	10	0			
„ Interest on Mortgage of £1,400 with the Institute and Coal-trade Chambers Company, Limited	49	0	0			
				317	10	0
To Sale of *Transactions*				108	0	6
To SUBSCRIPTIONS FOR YEAR 1903-1904 AS FOLLOWS:—						
751 Members ... ... @ £2 2s.	1,577	2	0			
91 Associate Members ... ... @ £2 2s.	191	2	0			
138 Associates ... ... @ £1 5s.	172	10	0			
62 Students ... ... @ £1 5s.	77	10	0			
64 New Members ... ... @ £2 2s.	134	8	0			
6 New Members (not yet elected) ... @ £2 2s.	12	12	0			
11 New Associate Members ... ... @ £2 2s.	23	2	0			
12 New Associates ... ... @ £1 5s.	15	0	0			
10 New Students ... ... @ £1 5s.	12	10	0			
	2,215	16	0			
23 Subscribing Firms	96	12	0			
2 New Subscribing Firms	4	4	0			
	2,316	12	0			
To LIFE COMPOSITION:—						
1 Member	27	0	0			
	2,343	12	0			
Less—Subscriptions for Current Year paid in advance at end of Last Year	74	6	0			
	2,269	6	0			
Add—Arrears received	236	6	0			
	2,505	12	0			
Add—Subscriptions paid in advance during the Current Year	72	13	0			
				2,578	5	
				£3,173	3	

F MINING AND MECHANICAL ENGINEERS. CR.

1904.

1904.	£	s.	d.	£	s.	d.
Report	34	9	6			
's Charges	21	11	0			
rs, etc.	63	14	11			
g Wood Memorial Hall, Offices, etc.	29	3	4			
tting Committee	13	15	3			
: Light	34	15	11			
es of Meetings	8	16	11			
surance	13	6	6			
... ...	17	8	3			
ire and Repairs	71	4	5			
tal Expenses	11	17	10			
Theatre: Alterations	133	0	0			
—Binding £77 3 0						
Books 47 5 3						
	124	8	3			
ash	6	3	5			
s—Circulars £44 18 9½						
Correspondence 23 10 3						
Publications 61 7 2½						
	129	16	3			
nd Taxes	5	18	7			
Offices	24	8	6			
ng of General Meetings	12	12	0			
, Wages, Auditing, etc.	529	3	0			
r Technical Library	16	2	6			
ry, etc.	35	5	11			
matter Index	58	9	8			
ne Rent	2	18	4			
tions of Papers	2	1	6			
Rate...	4	6	0			
				1,404	17	9
titution of Mining Engineers	1,366	16	7			
Amount paid by Authors for Excerpts ...	14	4	3			
				1,352	12	4
				2,757	10	1
at Bankers	359	18	3			
in Treasurer's hands	49	11	0			
ding Accounts due from Authors for Excerpts	6	4	0			
				415	13	3

ving examined the above accounts with the books, vouchers and elating thereto, certify that, in our opinion, it is correct.

JOHN G. BENSON AND SONS.
CHARTERED ACCOUNTANTS.

e-upon-Tyne, July 30th, 1904.

£3,173 3 4

Dr.	The Treasurer in Account					
		£	s.	d.	£	s. d.
To 921 Members.						
50 of whom have paid Life Compositions.						
871						
9 not included in printed list.						
880	@ £2 2s.	1,848	0	0		
1 Member paid Life Composition		27	0	0		
881					1,875	0 0
To 112 Associate Members,						
8 of whom have paid Life Compositions.						
104	@ £2 2s.				218	8 0
To 161 Associates,						
1 of whom has paid Life Composition.						
160						
3 paid as New Members.						
157						
1 not included in printed list.						
158	@ £1 5s.				197	10 0
To 69 Students	@ £1 5s.				86	5 0
To 23 Subscribing Firms					96	12 0
To 64 New Members	@ £2 2s.				134	8 0
To 6 New Members, not yet elected	... ...				12	12 0
70						
To 11 New Associate Members	@ £2 2s.				23	2 0
To 12 New Associates	@ £1 5s.				15	0 0
To 10 New Students	@ £1 5s.				12	10 0
To 2 New Subscribing Firms	@ £2 2s.				4	4 0
					2,675	11 0
To Arrears, as per Balance Sheet 1902-1903		306	4	0		
Add—Arrears considered irrecoverable, but since paid...		81	0	0		
					387	4 0
					3,062	15 0
To Subscriptions paid in advance					72	13 0
					£3,135	8 0

SUBSCRIPTIONS, 1903–1904. CR.

			PAID. £ s. d.	UNPAID. £ s. d.	STRUCK OFF LIST. £ s. d.
51	Members, paid	@ £2 2s.	1,577 2 0	.....	.....
1	,, paid Life Composition		27 0 0	.....	.....
93	,, unpaid ...	@ £2 2s.	.....	195 6 0	.....
3	,, excused payment	@ £2 2s.	.....	.....	6 6 0
5	,, dead	@ £2 2s.	.....	.....	10 10 0
28	,, struck off list	@ £2 2s.	.....	.....	58 16 0
91					
91	Associate Members, paid	@ £2 2s.	191 2 0	.....	.....
11	,, ,, unpaid	@ £2 2s.	.....	23 2 0	.....
2	,, ,, struck off list ...		.....	.....	4 4 0
94					
98	Associates, paid	@ £1 5s.	172 10 0	.....	.....
6	,, unpaid ...	@ £1 5s.	.....	20 0 0	.....
1	,, dead	@ £1 5s.	.....	.....	1 5 0
3	,, struck off list	@ £1 5s.	.....	.....	3 15 0
3					
7	Students, paid	@ £1 5s.	77 10 0	.....	.....
5	,, unpaid ...	@ £1 5s.	.....	7 10 0	.....
1	,, struck off list	@ £1 5s.	.....	.....	1 5 0
9					
8	Subscribing Firms, paid		96 12 0	.....	.....
14	New Members, paid ...	@ £2 2s.	134 8 0	.....	.....
5	New Members, not yet elected, paid	@ £2 2s.	12 12 0	.....	.....
9					
11	New Associate Members, paid	@ £2 2s.	23 2 0	.....	.....
12	New Associates, paid ...	@ £1 5s.	15 0 0	.....	.....
10	New Students, paid ...	@ £1 5s.	12 10 0	.....	.....
2	New Subscribing Firms, paid	@ £2 2s.	4 4 0	.....	.....
			2,343 12 0	245 18 0	86 1 0
	Arrears		236 6 0	64 0 0	86 18 0
			2,579 18 0		
	Subscriptions paid in advance		72 13 0	.....	.....
			2,652 11 0	309 18 0	172 19 0
					309 18 0
					2,652 11 0
					£3,135 8 0

General Statement, June 30th, 1904.

Liabilities.	£	s.	d.	£	s.	d.
Subscriptions paid in advance during the current year	72	13	0			
Ditto. in previous year	8	8	0			
				81	1	0
The Institution of Mining Engineers ...	...		...	45	19	1
Printing, etc.	...		...	19	5	10
The George Clementson Greenwell Prize Fund	100	0	0			
Less—Paid for Medals	67	8	4			
				32	11	8
Mr. Clarence R. Claghorn: Prize for Essay				10	0	0
Capital			...	11,528	11	5
				£11,717	9	0

We, having examined the above account with the books, vouchers and securities relating thereto, certify that, in our opinion, it is correct. We have accepted the assets, books, pictures, maps, etc., and *Transactions* and other Publications as valued by your Officials.

JOHN G. BENSON AND SONS,
Chartered Accountants.

Newcastle-upon-Tyne,
July 30th, 1904.

Assets.	£	s.	d.	£	s.	d.
Balance of Account at Bankers	359	18	3			
„ in Treasurer's hands	49	11	0			
Author's Excerpts	6	4	0			
				415	13	3
Arrears of Subscriptions			...	309	18	0
179 Shares in the Institute and Coal-trade Chambers Company, Limited (at cost) ...	4,100	0	0			
Investment with the Institute and Coal-trade Chambers Company, Limited (Mortgage)...	1,400	0	0			
				5,500	0	0
(Of the above amount, £1,511 is due to Life Subscriptions Account.)						
Value of *Transactions* and other Publications, as per Stock Account	341	17	9			
Books, Pictures, Maps, Furniture and Fittings	5,150	0	0			
				5 491	17	9
				£11.717	9	0

'RESENTATIVES ON THE COUNCIL OF THE NSTITUTION OF MINING ENGINEERS, 1904-1905.

'he RETIRING PRESIDENT (Mr. W. O. Wood) moved, and Mr. MAS DOUGLAS seconded a resolution that the following gentle- be elected as the representatives of the Institute on the ıcil of The Institution of Mining Engineers for the year -1905:—

'ILLIAM ARMSTRONG.
WTHIAN BELL, Bart.
. W. BENSON.
ENNETT H. BROUGH.
. G. CHARLETON.
HOMAS DOUGLAS.
. C. GREENWELL.
EGINALD GUTHRIE.
Mr. T. E. JOBLING.
Mr. PHILIP KIRKUP.
Mr. C. C. LEACH.
Mr. WILLIAM LOGAN.
Mr. HENRY LOUIS.
Mr. H. W. MARTIN.
Mr. GEORGE MAY.
Mr. JOHN MORISON.
Mr. HENRY PALMER.
Mr. M. W. PARRINGTON.
Mr. HENRY RICHARDSON.
Mr. A. R. SAWYER.
Mr. F. R. SIMPSON.
Mr. JOHN SIMPSON.
Mr. J. B. SIMPSON.
Mr. JOHN G. WEEKS.
Mr. W. O. WOOD.

'he resolution was agreed to.

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he following gentlemen were elected, having been previously nated:—

MEMBERS—

r. EDWARD S. FAWCETT, Colliery Manager, Battle Hill House, Walker-upon-Tyne.

r. THOMAS CAMPBELL FUTERS, Mechanical Engineer, Broomhill, Acklington, Northumberland.

r. THOMAS SPEAR HAWKINS, Mining Engineer, Millpond House, Hayle, Cornwall.

r. GUDBRAND HENRIKSEN, Inspector of Mines, Niels Juels Gade, 44, Christiania, Norway.

r. EDWARD JANITZKY, Analytical Chemist and Metallurgist, Pymble, near Sydney, New South Wales, Australia.

r. JOHN JAMES JOYNES, Mining Engineer and Colliery Manager. Ferndale, Lydbrook, Gloucestershire.

r. WILLIAM KIRKBY, Mining Engineer, c/o Aire and Calder Navigation, Leeds.

r. WILLIAM JAMES LARKE, Electrical Engineer, 59, Hillmorton Road, Rugby.

r. JOHN MORRIS, Colliery Manager, Achddu Colliery, Burry Port, Caermarthen.

r. ROBERT NELSON, Engineer, Western Villa, Wallsend-upon-Tyne.

r. NORMAN NISBET, Colliery Manager, Houghton Colliery Office, Houghton-le-Spring, R.S.O., County Durham.

r. WILLIAM REGINALD POTTER, Electrical Engineer, 17, Collingwood Street, Newcastle-upon-Tyne.

Mr. ROBERT FLEMING SMITH, Civil Engineer, Hunter's Villa, Parkside, Cleator Moor, Cumberland.

Mr. WILLIAM WOODEND SMITH, Mining Engineer, 3, Lonsdale Terrace, St. Bees, Cumberland.

Mr. ARTHUR MICHAEL TERRY, Locomotive and Inspecting Engineer, 20, Claremont Place, Gateshead-upon-Tyne.

Mr. JOHN TIZZARD, Electrical and Mechanical Engineer, 48, Hyde Terrace, Gosforth, Newcastle-upon-Tyne.

Mr. PHILIP IBOTSON UNWIN, Electrical Engineer, 50, New Bridge Street, Newcastle-upon-Tyne.

Mr. PERCY WIDDAS, Mining Engineer, Beechburn Grange, near Howden-le-Wear, R.S.O., County Durham.

Mr. ETHELBERT GEORGE WOODFORD, Consulting Engineer, P.O. Box 26, Johannesburg, Transvaal.

ASSOCIATE MEMBER—

Mr. LEONARD J. BATES, Oakdene, Claughton, Birkenhead.

ASSOCIATE—

Mr. BERTRAM ATKINSON, Mining Engineer and Colliery Manager, 2, Devonshire Terrace, Newcastle-upon-Tyne.

STUDENT—

Mr. JOSEPH NOEL WALKER, Mining Student, Durham College of Science, Newcastle-upon-Tyne.

SUBSCRIBERS—

THE BROKEN HILL PROPRIETARY COMPANY, LIMITED, 3, Great Winchester Street, London, E.C.

Messrs. OSBECK AND COMPANY, Newcastle-upon-Tyne.

DISCUSSION OF MR. W. O. WOOD'S PAPER ON "THE RE-TUBBING OF THE MIDDLE PIT, MURTON COLLIERY, 1903."*

Mr. HENRY LAWRENCE (Newcastle-upon-Tyne) said that the operation described in the paper was a very difficult and dangerous one, and he had no doubt that the experience which the President, together with his engineer and manager, had had with previous difficulties and dangers in the same direction was of great value. The facing of the vertical joints of each segment of tubbing, the bolting of the required number into a ring, metal to metal, and then turning the horizontal joints of each ring in a lathe, made the segment perfect in strength, and avoided what sometimes happened, namely, a blown-out segment. The filling of the cement, so that the joints of the

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 197.

ıould not come opposite to a joint of the tubbing, him to be very ingenious. He asked whether the a downcast one only, and what was the temperature the tubbing. If there was any great heat, it would affect the expansion. He also asked whether any l been taken towards preventing decay on the inner tubbing, by the use of any kind of coating. The use panels placed in the face of the tubbing was necessary ast shaft; and his experience of tubbing, after a years, was that sometimes the gases were so trouble- a knife could cut what was originally cast-iron.

C. LEACH asked whether any tests had been made of used in the tubbing.

. O. WOOD, replying to the discussion, said that the re of the water behind the tubbing was about 50° e middle pit was a downcast shaft, and was therefore ıe variations of summer and winter temperature. The ıg was very tender, and they adopted a means of the temperature during the winter months by caus- f the air, in descending the pit, to pass through radi- ed by the waste-steam from the engines on the sur- by this means the temperature of the shaft (even in cold weather) was maintained at about 42° Fahr.— above freezing point. They were very anxious to excessive cold in the winter, as they were afraid cts of contraction upon the old tubbing. The larger reviously in use, would now be dispensed with. A ıs also used for increasing the temperature of the east ame colliery. The segments of tubbing were coated cial anti-corrosive fluid or paint, the tubbing being) it when hot, and the coating adhered very strongly. orizontal and vertical joints were covered with tallow, corrosion, until they were put into position. Every ıe tubbing was tested; and it was made to a rigid n, as to the quality and mixtures of iron. Special cast and broken under test-conditions.

. C. BLACKETT asked whether any reliance was now the old tubbing.

Mr. W. O. Wood said that the old tubbing was still intact in the pit, and reliance was placed on it. It had been in the pit for 70 years, and, for the most part, it was water-tight. There were a few leakages, some had been stopped, and it was thought prudent to allow others to continue. Air or gas might accumulate behind the tubbing, and unless it was allowed vent, there was danger of the tubbing moving.

Mr. W. C. Blackett remarked that there might be a little doubt about the old tubbing; formerly, it would be wedged and held in position by the pressure of water behind it. So long as that pressure was there, it would be held tightly, but subsequently when they had another lining, and if the pressure of water was equalized by a possible space between the old and the new tubbing, the former stability might be changed.

Mr. W. O. Wood said that, if the water-pressure had been allowed to pass in front of the old tubbing, such would have been the case; but the new lining was put in front of the old one, and the space between the two linings was made perfectly solid with cement-concrete, so that the old tubbing and the new became practically homogenous. The water-pressure remained on the old tubbing, which was strengthened by the cement-concrete and the new metal tubbing.

DISCUSSION OF MR. A. A. ATKINSON'S PAPER ON "WORKING COAL UNDER THE RIVER HUNTER," ETC.*

Mr. A. A. Atkinson (Sydney, New South Wales), wrote that the particulars given by Mr. R. H. Brown with regard to under-sea coal working at collieries under his management, were very interesting. He (Mr. Atkinson) could not, however, agree with Mr. Brown that "the subsidence due to the removal of a bed of coal, 6 feet thick, would probably, under these conditions, soon choke itself, so that there would be no actual settling or motion of the strata for more than 100 feet above the seam; and above that point the elasticity of the beds, already mentioned, would prevent any rupture."†

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 622; and vol. xxvi., page 254.

† *Ibid.*, vol. xxvi., page 256.

Where a considerable area of coal has been entirely excavated from such a thickness of seam as that referred to, and at a depth of about 1,000 feet, in ordinary coal-measures (as indicated by the section), and without any packing in the goaf, it is usual to find a bending of the strata, and a considerable subsidence of the surface; but the rupture of the rocks may not be sufficient to let down surface-waters. It is, therefore, probable that, in this instance, the bed of the ocean will be considerably lowered, after a sufficient area of goaf is formed by the total removal of the coal: the process being simply a bending of the strata above the point of rupture, which Mr. Brown suggests will be found about 100 feet above the seam. Proof that this subsidence has taken place could probably be obtained by soundings taken after a large area of goaf has been formed. Subsidence of the surface has followed the removal of seams no thicker than this, and at a much greater depth.

If the Sydney Main seam admits of the adoption of a good long-wall system (and this appears to have been tried), wherever the total extraction of the coal is intended in the under-sea working of this seam, it would probably be advisable to adopt that system in preference to bord-and-pillar; as in longwall the possibility of serious fracture of the strata is somewhat reduced by the more gradual subsiding of a long face, and the effect of packing the goaf. This would, to some extent, reduce the possibility of letting down feeders of water.

No rigid rule can be drafted for the extraction of coal in under-sea workings, as so much depends upon local conditions. It would be interesting, however, to know at what minimum thickness of strata between the seam and the bed of the ocean, it is intended to cease the removal of pillars now formed, in the collieries under Mr. Brown's control.

Dr. James R. M. Robertson (Sydney, New South Wales) wrote that the interest taken in the prosecution of working coal not only under the estuary of the Hunter river, but under the bed of the Pacific Ocean, at and contiguous to Newcastle, and the importance of winning the same under safe conditions, must be his apology for offering a few remarks on Mr. Atkinson's interesting paper.

In the vicinity of Newcastle, the lower or Bore-hole seam, along the ocean beach, is found at a comparatively shallow

depth; while, to the northwest and west, its outcrop crosses the river, where it is covered by a considerable thickness of sand and detritus and a thick bed of plastic clay; then it follows the irregular contour of low undulating country some distance south of the Hunter river.

Contiguous to the loading-staiths* on "The Dyke," the Bullock Island and Hetton collieries have been sunk through the fluviatile deposits by means of cast-iron cylinders and have tapped the coal-seam, where it was overlain by only a few feet of solid strata, which, however, in turn were overlain by a bed of impervious clay; and to this much of the immunity from serious accidents as a result of the falls or crushes (notwithstanding the conditions in the leases) that have occurred is undoubtedly due. To the north and west of these shafts, loose sea-sand and gravel form the roof of the coal-seam; indeed a considerable area, adjacent to Throsby Creek, of thick coal was worked under a roof of sand.† To the rise of Stockton colliery, the strata overlying the coal-seam have been denuded away, and deposits of sand and drift approach perilously close to the coal-seam.

The terms and conditions of the leases granted for sub-ocean coal-mining appear to comply with the recommendations of the Ferndale Royal Commission, which first called attention to the necessity for special provision in the case of mining coal under the ocean.

The Bore-hole seam, at or contiguous to the ocean beach at Newcastle, measures from 15 to 16 feet in thickness, but gradually thins towards the south. In some of the collieries, such a seam has been worked for long distances seaward under the condition mentioned by Mr. Atkinson. At the Inner Nobbys, the seam exists about 155 feet under high-water mark. The roof of this seam consists of arenaceous schists, and of coarse jointed sandstones with well-developed facings or cleavage-planes, and is freely intersected by basalt-dykes.

Mr. Atkinson is content to refer to "an igneous dyke at Nobbys"‡ (two prominent stratified eminences that guard the southern entrance of the harbour). As a matter of fact, however, "a basalt-dyke" with a north-westerly trend, intersects both

* The hydraulic cranes where coal is shipped.

† *Trans. Inst. M.E.*, 1902, vol. xxiii., plate XXX., page 660.

‡ *Ibid.*, vol. xxiii., page 625.

the Outer and Inner Nobbys, and there are suspicions of another in the shallows between these points, while at comparatively short intervals to the south, several basalt-dykes intersect the shelving sea-beach and sea-cliffs. These cross the harbour, and have worked woeful havoc with the coal-seams in the Hetton and Stockton collieries.

Mr. Atkinson very properly pointed out that there is nothing novel in working coal-seams under the bed of the ocean. A large proportion of coal is obtained under the ocean in Japan; and extensive workings of coal are being carried on under the sea in Nova Scotia. For many years, coal-workings have been conducted for long distances under the Irish Channel (in one case with disastrous results), under the Firth of Forth, and especially under the German Ocean at the large and well-conducted collieries of Cambois, Cowpen and others. In one case, a very heavy feeder of salt-water was tapped in a mine driven through a basalt-dyke nearly 600 feet under high-water mark, and many similar instances were known to the Ferndale Royal Commission when they framed their report about eighteen years ago. Since then, similar occurrences have been experienced here. On the Northumberland coast of Great Britain, the Department of Woods and Forests have been advised to limit coal-workings under the German Ocean to situations where, above a seam 3 feet thick that is worked, there is a minimum thickness of 300 feet, and in another case, where a similar coal-seam is worked, a minimum of 270 feet of solid strata must be left above the seam. In that area, the bed of the ocean consists, he understood, of stiff bluish clay, while there are no basalt-dykes and faults are few.

In Newcastle, New South Wales, the coal-seam is thick, with a jointy arenaceous roof, with facings that cut through the stratified beds, and both are broken and are freely intersected by basalt-dykes, which readily decompose on exposure. The ocean-bed, so far as he (Dr. Robertson) is aware, consists of sand and comminuated fragments of shells, etc.

The author stated that the Department of Mines stipulated for a thickness of 120 feet of strata above the ocean coal to be worked. No reasons are adduced for this limit of thickness, so much less than that considered necessary in Great Britain. It can scarcely be considered sufficient because a certain size

of pillar and of bords have hitherto resisted crushing. In some of the harbour and ocean collieries, extensive falls of roof and crushes of pillars have occurred where such conditions prevailed, and it is manifest that in large areas of such collieries nothing approaching 150 feet of solid strata existed above the coal-seam. In these collieries, or in some of them, sand and salt-water to an alarming extent have come down from the roof. In consequence of such occurrences, at least one extensive district has been enclosed and abandoned. There are really no satisfactory solid sound strata above the coal-seam at No. 3 Stockton shaft, while a short distance to the north the superincumbent strata may be expected to be entirely denuded.

He (Dr. Robertson) is convinced that 120 feet of such strata, broken as they are by basalt-dykes and "thills" injected or interbedded with the coal-seam and strata, are insufficient protection for the safe working of these collieries or insufficient, at all events, to allay public anxiety.

For upwards of 1 mile south of Newcastle, the depth of the Bore-hole seam does not exceed 175 feet under high-water mark. Between Shepherds Hill (on which the higher portion of the city is built) and the Newcastle Company's colliery is a broad depression, the surface being little above sea-level and filled with thick deposits of sand. This is evidently an ancient mouth of the Hunter river, or of an estuary that joined that of the Hunter. At the Australian Agricultural Company's Hamilton collieries, the depth of this sand nearly approaches the horizon of the coal-seam; and, in all probability this depth will be continued seaward. He (Dr. Robertson) is not aware that the depth of this sand has been accurately ascertained on the sea-coast or under the ocean, which is leased for working coal.

While the provisions of the leases as to the size of pillars and width of bords, if observed, may be sufficient for coal as shallow as the seams described, more ample provisions for strength and security are obviously required in collieries where the depth is greater, especially where the surface-deposits are thick.

In his (Dr. Robertson's) opinion, the chief danger in working this thick coal-seam under the bed of the Pacific Ocean, at or near Newcastle, will be found in the jointed or fissured strata overlying the coal-seam, the probable absence of clay on the

l of the ocean, the weakening influence of the intrusions of salt, and the possibility of narrow crevices in the strata ıilar to those that intersect the rocky ridges adjacent to the sea.

If for thin seams of coal, not intersected by basalt or faults d with favourable conditions of the sea-bottom, a depth of 270 d 300 feet is considered necessary in Great Britain, it is not ry clear why in the light of recent events only 120 feet should, der less advantageous conditions existing here (New South ales) and with practically no detailed knowledge of the sea-ttom, be considered sufficient protection to collieries and the es of the workmen.

The fact of sand and salt-water coming down from falls in e roof or from fissures in dykes is not pleasant to contemplate; d he (Dr. Robertson) thought that this suggests more ringent provisions than those contained in the present leases. ıe unknown condition of the sea-bottom is a matter of import-ıce, not, in his opinion, sufficiently emphasized in Mr. Atkin-n's valuable paper.

In connection with this subject it is fitting to mention that e workings of several of the inland collieries communicate with ose undermining the ocean-bed, so that a possible catastrophe ɔuld not be confined to one, but would, in all probability, :tend to several collieries. The dire effects would be far-aching.

The history of undersea workings in New South Wales had late years supplied object-lessons sufficiently grave to justify revision of the present leasing conditions of the undersea al, in order to ensure that measure of safety which is necessary essential to such undertakings; and to satisfy the desire of the ıblic and contiguous mine-owners that everything that can nduce to safety is being enforced, and that all reasonable pro-sions calculated to prevent accidents are being applied.

He (Dr. Robertson) thought that Mr. Atkinson deserved the anks of the members for his timely and valuable paper.

Mr. William Humble (Senior Inspector of Collieries) wrote ıat, since Mr. Atkinson's valuable paper was written, the llowing points of general interest had been met with in the orking of river and sea coal in New South Wales.

Vertical bore-holes into the roof of one of a pair of winning laces, 218 feet below high-water mark, proved sand and

shingle, 15, 26, 24, 26 and 35 feet above the seam, and this promptly determined the stoppage of the places. Adjacent thereto, where the cover is 238 feet thick, a small fall of roof in a narrow bord, 10 or 12 feet wide, let in some water accompanied by a little sand. Holes bored in the roof, on both sides of this fall (one on the inbye-side, and close to the weak spot) after the fall occurred, proved good hard stone for the length of each hole, from 30 to 50 feet. Finally, a brick-dam, 9 feet thick, was built; and, on completion, a gauge placed thereon indicated a pressure of 67 pounds per square inch or a head of 157 feet.

In another part of the mine, not under the sea, but probably subject to its influence, a sheth of bords was stopped on reaching what had apparently been one of the old channels referred to in Mr. Atkinson's paper. In several places, a mixture of sand and clay, together with the decomposed trunk of a tree, made its appearance; and, in one place, clay replaced part of the seam. The thickness of cover was 186 feet. The places were barred off by barricades composed of props and slabs, with mine-débris packed between. These barricades acted very efficiently in arresting the sand and soft clay, where, with a little water, there was a tendency of some of the falls to "run." Very little water, however, came off. Prior to the stoppage of these places, and some time before the falls occurred, roof-holes had been bored, indicating the presence of fairly thick beds of clay. In one hole, the section was as follows:—Boulder clay, 3 feet; strong dry clay, 24 feet; shale, 1 foot; clay, 1 foot; shale, 12 feet; and coal and bands, 4½ feet.

In another mine, a little water issued from a fissure in the floor of a narrow bord at the leader of a rise fault, the throw of which is estimated to be 30 to 35 feet. As this and its accompanying place were then at the cover-limit of 120 feet, they were barred off with brick-dams. Little or no water has ever been made in this area, the quantity here referred to, being only about 6 or 8 gallons per minute.

In a third mine, a coarse sand was found at a height of 15 feet in a roof-hole, in one of the winnings, where the cover is about 200 feet thick. The hole passed through 15 feet of sand, and was then stopped; and the extension of work in this direction has in consequence been abandoned. There is ver

little water, and none issued from the bore-hole. This occurrence took place about 37 chains south of Walsh island, where, two or three years ago, a bore-hole, put down from the surface, proved the seam to have been entirely removed; alluvial deposits were found resting directly on the hard-grey sandstone floor so characteristic of the Bore-hole seam.

Quite recently, in another pair of winning places in the same mine, an open fissure, containing water, was proved by a horizontal advance hole, which was bored 33 feet through dykestone and the attendant cinder-coal. One of the provisions of the Crown lease, under which the coal is worked, requires that the holes shall be bored at least 10 feet in advance of the face; but the manager had decided to prove the thickness of the dyke and the distance to be driven to get at the undamaged coal beyond, before commencing to drive through it. In doing this, the water was found at 33 feet, and, on the hole being fitted with a pipe, a gauge placed thereon recorded a pressure of 87 pounds per square inch. Later on, however, another hole registered a pressure of only 55 pounds per square inch. In all, four holes were bored in these two places, all getting the water at about the same distance. The last hole was designedly sloped upwards, in order to get into the roof-stone beyond the dyke. One of the four pipes, on being opened, ran water at the rate of about 20 gallons per minute, but as all of the holes have not been opened at the same time the total feeder has not been measured. The cover is 236 feet thick.

These few details will, it is hoped, be of interest to members concerned in the winning and working of under-sea coal. Such coal, in the northern district of New South Wales lies, unfortunately, at shallow depths, probably nowhere exceeding 300 or 310 feet, and its winning has entailed great care and watchfulness on the part of the manager and officials of each mine. Since 1890 or 1891, when one life was lost in a small mine at Tighes Hill by the sudden incursion of tidal water from Throsby creek, there have been no casualties in the prosecution of sea-coal working, a fact which reflects favourably on the persons responsible for the management of the mines and the safety of the workmen.

Mr. Wm. B. Pendleton (Corrimal, N.S.W.) wrote that the principal feature of Mr. Atkinson's paper was an exposition of

the comparatively narrow margin of security, given by the limited thickness of cover in every instance. The safe working of the mines would be a severe tax upon the ability of the colliery managers, more especially when under the waters of the Pacific Ocean. Perhaps one of the greatest dangers to which submarine mining was subject was that of erosion; this might only occur in isolated areas wearing away the roof in a dangerously thin degree, or it might take the form of a "wash-out" as it was locally termed. The partial thinning of the roof was probably the most serious danger, because of its liability to be unsuspected; the roof might be sufficiently tenacious to permit the extraction of even a considerable quantity of coal, but eventually it might collapse, and then the workers' retreat would be cut off, with a certainty of pecuniary loss to the proprietor, and possibly something worse to the workmen: such disasters had happened in the district, even where the narrowest of headings was the scene of collapse.

In the discussion upon the paper, Mr. Thomas Bell recommended a reduction of the width of the working-places: such a reduction from 24 feet to 12 feet was certainly in the correct direction to secure safety, but when the collapse of roof mentioned in the last paragraph was known to occur in a heading, only 8 feet wide, it was easily seen that working-places of profitable width did not afford absolute security.

Almost absolute security could be attained by following the direction of Mr. H. M. Cadell, who recommended the re-filling of the wastes with sand. Such "stowing" would give a perfect sense of safety to the underground worker, and cost no more than an adequate insurance-premium to the owners. Mr. Cadell had pointed to the "flushing" in the coal-mines of Pennsylvania, as an illustration of his suggestion: water in this case being an absolute necessity, on account of the variable specific gravity and size of the particles transported.

In the case of sand being substituted for culm, the engineer had a material to manipulate, which had entirely different characteristics; its particles did not vary much in size and still less in specific gravity, all being properties which were admirably adapted to the conveyance by air under pressure. It appeared that the substitution of air for water would overcome the insuperable difficulty of expense: as a vehicle for the trans-

port of the materials mentioned, no one would deny the superiority of water, but its advantages were more than offset by the necessity of pumping it back to the surface. It would be noted how even small quantities of water inconvenienced the operations of a mine in the case of Hetton colliery. Sand was especially easy to move by air-currents, and this had been observed in the district of Newcastle, by every engineer for many years past. Large sums of money had been spent in mitigating the evil effects of sand-movement by atmospheric influences.

Mr. JESSE GREGSON wrote that little more could be said about the subject until further knowledge was gained by extended workings under the sea-bed. At present, it would seem that the Dudley and other collieries, situated 8 or 10 miles south of Newcastle, would be better able to work the sea-coal than their neighbours, as they had more cover. Nearer Newcastle, the cover quickly diminished, owing to the rise of the seams and the dip of the sea-bed.

DISCUSSION OF MR. R. R. SIMPSON'S PAPER ON "WELL-SINKING IN THE PUNJAB."*

Mr. F. L. G. SIMPSON (Mohpani Mines, India) wrote that the method of sinking through sands and quicksands, described by Mr. R. R. Simpson, was not in use among the native well-sinkers of the Central Provinces, so far as he was aware. In one respect, their practice resembled that of the Punjab, namely:—In sinking to considerable depths, through sandy clays, and even through sands with very little clay, without any means of securing the sides. In a recent case, under his notice, a native contractor well-sinker sank a well, 8 feet in diameter, to a depth of 45 feet in sand, slightly mixed with clay, without inserting any support for the sides. The contractor then put in a walling-crib, and built the brick-walling 13 inches thick, to the surface, without any accident, except a few dozen baskets of stuff falling off near the bottom, where it was just beginning to be damp. The contractor next continued sinking, at the reduced diameter of the well, after driving iron-bars into the sides below the crib, and sank about

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 47.

20 feet further (again without using any support for the sides), where he met water, and walled up at a further reduced diameter with walling 9 inches thick, to the first walling-crib. The whole proceeding was quickly carried out, and this accounted for the success of a method that would not be even thought of by any experienced European sinker, and that often failed with the Indian.

The Punjab system, except for the risk of not securing the upper portion while sinking, appeared to be practically equal to any European method employed for the same purpose.

Mr. GEORGE A. STONIER (Chief Inspector of Mines in India) wrote that Mr. R. R. Simpson described the method of sinking in dry or slightly wet sand. When the water could not be kept out of the well by pumping or lifting, the Indian native in Bengal and Punjab used a *jham* to excavate the sand or clay, and allowed the cylinder to sink. This tool, *a*, was made of wrought-iron, hoe-like in form (28 inches to 36 inches long and 26 inches wide), with a sharp lower edge, and fitted with two iron-rods, 12 inches in length, which corresponded to the handle of a bucket and came from the upper and lower edges to an iron-ring: a rope, *b*, was attached to the latter and passed round a wooden jack-roll, *c*, or over a pulley at the surface. The jham, *a*, was lowered into the well and worked into the sand by the well-sinkers, who dived under the water to a maximum depth of 13 feet or pressed on a long wooden pole, *d*, 20 or 30 feet in length, fitted into an iron-socket at the upper edge of the jham. On the removal of the pole, the jham and its load of sand were wound to the surface by the aid of the jack-roll (Figs. 1 and 2, Plate V.). For excavating wells, for the foundations of important bridges, in very wet ground, Europeans had used an improved form of the jham; but in recent years it had been abandoned in favour of dredges and sand-pumps or iron-cylinders supplied with compressed air.

In some districts, the wooden curb was composed of small bamboos, which were split in two, wound spirally, and tied securely to small pieces of bamboo placed radially underneath: and the interstices were filled with grass. For square wells, the bamboos were laid side by side, and tied to short strips placed underneath, being also strengthened by lashing at the corners.

The lining of brickwork or masonry was set in thin clay or mortar—the eyes of the divers were said to suffer from the use of the latter—and, in some districts, straw-ropes were tightly wound round the walls to keep the bricks in position while the cylinder was sinking.

The Persian wheel was in common use in the Punjab, and might be single or double. The actual discharge of the latter was generally stated to be nearly three times as much as the former, and to be about 1,200 gallons per hour. In the Central Provinces, single wheels were worked by manual labour. The drum (4 feet long and 3½ feet in diameter) was skeleton in form, with open ends. A wooden shaft, 8 inches in diameter at the centre and tapering to 3 inches at the ends, was fitted with three sets of wooden arms or spokes (five in each set) at the centre, supporting ten horizontal longitudinal bars 2 inches in diameter, the ends of which were kept in position by ten small flat pieces of wood, forming the flanges of the drum. Two endless two-stranded ropes (½ inch in diameter and spaced 7 inches apart) passed over the drum and carried earthenware jars, each of which was tied by rope to two small horizontal sticks thrust between the strands of the endless ropes. A man, who sat on a plank at a convenient height, pressed on the longitudinal bars with his hands and feet, and caused the drum to rotate, raising the jars to the surface, where they were emptied of their contents (Figs. 3 and 4, Plate V.).

DISCUSSSION OF MR. J. M. MACLAREN'S PAPER ON "THE OCCURRENCE OF GOLD IN GREAT BRITAIN AND IRELAND."*

Mr. J. Postlethwaite (Keswick) wrote that he had read Mr. Maclaren's paper with much interest, the more so because in February, 1879, he had read a paper on "Gold-mining in Britain" before the members of the Keswick Literary and Scientific Society, treating of the same localities, but in a much less exhaustive manner. On that occasion, Mr. J. Clifton Ward, who was present, exhibited a small piece of glass to which were attached a number of flakes and grains of gold, which had been extracted from quartz obtained from a mineral vein in Borrowdale, Cumberland.

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 435; and 1904, vol. xxvii., page 126.

The invention and construction of the Berdan machine for gold-recovery in 1853 (mentioned by Mr. Maclaren*) caused many mine-proprietors to examine more minutely the mineral constituents of the veins in their various properties, and samples of quartz and gossan were sent from Brandlehow mine, on the south-western margin of Derwentwater, for treatment in that machine; the result being that gold was found in both the quartz and gossan, the latter yielding the greater quantity, but neither of them containing sufficient to pay for extraction. Attempts were also made at that time to find gold in gravels and alluvial deposits in the neighbourhood of Keswick, Buttermere and Loweswater, but there is no properly authenticated record of gold having been found in any alluvial deposit in the districts named.

With regard to the copper-ores raised at Goldscope mine, in the reign of Queen Elizabeth, the old records contain abundant proof that the ore yielded gold in considerable quantities. Indeed evidence was given by experts at the hearing of the great law-suit between the Queen and Earl Percy, that the gold contained in the ore was of greater value than the copper with which it was associated. Goldscope mine was reopened as a copper mine in 1847, but so far as he (Mr. Postlethwaite) had been able to ascertain, no gold was obtained from the ore raised at that time; nor was there any reference to gold in the records respecting the working of the mine from 1690 to 1715 and onward copper being the only product mentioned. In all probability there was the same irregularity in the quality of the copper-ore in Goldscope vein as had been found to prevail in quartz-veins in the Clogan, Dol-y-frwynog, Cwm Eisen and other Welsh mines. In these, the rich auriferous quartz occurred in detached shoots or runs, while the intervening portions contained little or no gold; and one might reasonably infer that in like manner the copper-pyrites worked by the German miners in the open cuts and shallow workings at Goldscope was richly auriferous, but that little or no gold had been found in the ore obtained from other parts of the mine. Similar conditions had actually been observed in the Coniston Mine. Mr. Charles E. De Rance stated that when he was engaged, more than twenty years ago, as an officer of the Geological Survey in the southern portion of the

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 443.

English Lake District, he discovered visible gold in one of the veins of the Coniston copper-mine. He further stated that the specimens of this ore were examined by Sir Andrew Ramsey, Sir Warington W. Smyth, Dr. John Percy and other experts, all of whom confirmed his identification; and yet it does not appear that any further production of gold followed that discovery, nor is there any previous record of gold having been found in that mine during its lengthened history of nearly 2,000 years.

One of the most striking features connected with British gold-mining consists in the varied conditions under which the precious metal occurs. In geological time, it ranges from Lower Ordovician to Lower Carboniferous; and it is found in many localities, sometimes in its native state, and also associated with a large number of other minerals.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

EXCURSION MEETING,

HELD FROM SEPTEMBER 19TH TO 23RD, 1904.

The PRESIDENT (Mr. Thomas William Benson) and the Council received the members of the Association des Ingénieurs sortis de l'École de Liége and the members of the Institute, in the Wood Memorial Hall, on September 19th, 1904.

The PRESIDENT extended a cordial invitation to the North of England to their friends from "across the water." He assured them that they were visiting a very ancient city, and one of the oldest coal-fields in the world. He hoped that their visit would be pleasant and instructive, and that the programme of visits to collieries and works would meet with their approval. The Institute felt extremely obliged to the various manufacturers and colliery-owners of the district for so kindly placing their works at the disposal of that company.

Mr. A. L. STEAVENSON, in supporting the welcome, said that they had often been told that the gentlemen on the other side of the Channel and the other side of the Atlantic had gone far ahead of them in this country. He for one never believed it, and he thought that they might take that visit from Belgian engineers as a testimony that there was still something interesting and instructive to see in Great Britain. After they had gone round their collieries, they would conclude that this country was in no wise behind its rivals. He had been in Belgium, but he had not been down any of the pits, he understood, however, that there the coal-seams were lying too awkwardly to be worked economically. Here, things were different, there was still an immense quantity of coal in this country, if it could be worked economically; but as they got deeper down and had large bodies of water to deal with, possibly working would become more difficult. With their increased knowledge

engineering and the assistance of their colleges, they hoped to be able, despite such difficulties, to keep their place among the nations of the world.

The SHERIFF OF NEWCASTLE (Mr. William Cowell), who apologized for the absence of the Mayor, and joined officially in the welcome to Newcastle, said that they had on the Tyne many different manufactures of which they were very proud, and he hoped that the members would take the opportunities afforded of seeing them.

Mr. JULES MAGERY (President of the Association des Ingénieurs sortis de l'École de Liége), in returning thanks, expressed his deep sense of the honour paid them, and the wish that a profitable meeting during the forthcoming few days would eventuate.

The following notes record some of the features of interest seen by visitors to collieries, works, etc., which were, by kind permission of the owners, open for inspection during the course of the Newcastle-upon-Tyne meeting on September 19th, 20th, 21st, 22nd and 23rd, 1904:—

DAWDON COLLIERY.

The first sod of the Theresa or south shaft was cut by the Marchioness of Londonderry, and that of the Castlereagh or north shaft by Viscount Castlereagh on August 26th, 1899.

Sinking operations were commenced on April 17th, 1900. The shafts, which are to be sunk to a depth of about 1,800 feet, will be 20 feet in diameter, when completed.

Theresa Pit.—The Theresa shaft has been sunk to a depth of 354 feet, the first 96 feet being lined with bricks and 225 feet with cast-iron tubbing. The first wedging-crib, put in at a depth of 194 feet, reduced the feeders from 6,075 to 1,100 gallons per minute. The second bed, made at a depth of 227 feet, reduced the feeders from 2,850 to 1,470 gallons per minute. The next crib, set at a depth of 237 feet, reduced the feeders from 1,560 to 400 gallons per minute. The last bed, put in at a depth of 328 feet, reduced the feeders from 1,720 to 380 gallons per minute.

After sinking 32 feet in strong limestone, several holes, 3 inches in diameter, were bored in the bottom with a rock-drill so as to prove the sand. It was found that the latter was 19 feet below the present pit-bottom, and that it was about 84 feet thick.

In this shaft, there were pumps capable of dealing with 7,000 gallons per minute, namely, two lifting sets 24 inches in diameter, and one 25 inches in diameter and two Evans vertical Cornish sinking pumps, 24 inches and 16 inches in diameter respectively, by 24 inches stroke. These pumps all delivered into a drift about 90 feet below the surface, from which the water ran to the sea-beach.

After proving the sand, sinking operations were suspended, until the Castlereagh shaft should reach the same depth, so that both pits might be taken through the sand together.

Castlereagh Pit.—The Castlereagh shaft contains 96 feet of brick-lining at the surface, and 88 feet of cast-iron tubbing. The first lift, put in from a depth of 140 feet, reduced the feeders from 1,520 to 735 gallons per minute; and the second lift, put in from a depth of 185 feet, reduced the feeders from 4,580 to 380 gallons per minute.

From this point, a bore-hole lined with tubes, 9½ inches in diameter, was put down to a drift which had been driven from near the bottom of the Theresa shaft to convey the water to the pumps in that pit.

Two Evans pumps, similar to those in the other shaft, and two pairs of pulsometers in series were put in, and the pit was sunk with these to a depth of 204 feet. Another lift of tubing was now put in from a depth of 200 feet, but this only reduced the feeders from 5,750 to 4,050 gallons per minute.

At this time, owing to the great quantity of water and the great thickness of the sand, it was decided to freeze the shafts, so as to sink through the sand rather than erect duplicate pumping plant. All pumps, etc., were taken out of the shafts and the contract for freezing was let to Messrs. Gebhardt and Koenig, of Nordhausen, in Germany.

Boring and Freezing.—The work of erecting the boring-machines was commenced at the Castlereagh shaft on May 8th,

1903. Three boring-machines and a vertical engine for driving them were fixed, and three small Worthington pumps for pumping water into the bore-holes. Two steam-winches were also erected for lifting and lowering the rods and tubes.

Work at the Theresa shaft was commenced shortly afterwards with four boring-machines of the free-fall type, together with four small pumps for pumping water into the bore-holes; also two belt-driven winches and one steam-winch for lifting and lowering the rods and tubes. The bore-rods and chisels were made of wrought-iron, with a hole, 1¼ inches in diameter, passing down the centre, through which water was pumped for the purpose of washing out the borings.

Before commencing to bore, a fore-shaft, 36 feet in diameter, was sunk to a depth of 8 feet at each pit, and from the bottom, boring was commenced.

The bore-holes (28 at each pit) were spaced at equal distances around a circle, 30 feet in diameter. They had an average depth of 484 feet, and were bored on the average in 25 days. The holes were bored to a depth of 130 feet with a chisel 9⅞ inches in diameter, and then lined with tubes, 9½ inches in diameter; the next 330 feet, with a chisel 8 inches in diameter and lined with tubes, 7½ inches in diameter; and the last 24 feet, with a chisel 6⅝ inches in diameter; and the whole was lined out with tubes, 6¼ inches in diameter.

The outside freezing tubes, 5 inches in diameter, were next put in, the bottom tube-end being closed, and tested by hydraulic pressure to see whether they were properly water-tight.

Into these tubes, the 2½ inches tubes, were then placed to a distance of 33 feet above the bottom of the tubing, fitting into a double nipple screwed into the 5 inches tubes; and these also were tested by hydraulic pressure. The air-space between the tubes, 2½ inches and 5 inches in diameter, isolates the strata above the double nipple and so prevents them from freezing.

All water being removed from the tubes, tubes, 1¼ inches in diameter, were put down to the bottom, having the bottom length perforated so as to allow of the brine pumped into them returning up the outer tubes. All the tubes were made of wrought-iron.

After the freezing tubes were inserted, the lining tubes were withdrawn.

During the boring operations, the freezing machinery was erected, the plant consisting of three compressors driven by two horizontal engines, two brine-pumps, five tanks for cooling the gases, and four tanks for cooling the brine. The freezing plant was connected to the Castlereagh shaft on April 22nd, 1904, and to part of the Theresa shaft on June 10th, 1904.

The brine is pumped into the holes at temperatures varying between 12° and 3° Fahr., and the temperature of the brine from the pits varies from 21° to 12° Fahr. The water used for cooling the compressed ammonia is warmed from about 50° to 64° Fahr.

The engines used for sinking, which will eventually be used as underground hauling-engines, have cylinders 24 inches in diameter and 4 feet stroke. The drums are 8 feet in diameter and 6 feet wide. Locked-coil ropes are used, $3\frac{3}{4}$ inches in circumference.

The pumping-engine, which was used for driving the pumping sets at the Theresa shaft, has cylinders 36 inches in diameter and 6 feet stroke. The flywheel is 24 feet in diameter.

There are eight Galloway boilers, 30 feet long and 8 feet in diameter. The working-pressure is 100 pounds to the square inch.

Four sets of Green fuel-economizers of 120 tubes each are in use. The temperature of the feed-water is raised from 85° to 280° Fahr., when all the boilers are at work.

The chimney for the Galloway boilers is 160 feet high, its base is 24 feet square, and the inside diameter at the top is 12 feet.

The water-softeners, of the Archbutt-Deeley type, are capable of treating 60,000 gallons per day. The water is reduced from 16 degrees of hardness to 4 or 5 degrees by the treatment. About 40 pounds of lime and 7 pounds of alkali are used for each tank treated, at a cost of about $\frac{1}{2}$d. per 1,000 gallons.

One of the permanent winding-engine houses has been built, and the foundations of the other one are also put in. The winding-engines will be of the horizontal type, having Corliss valves, with cylinders 40 inches in diameter and 6 feet stroke. The winding drum will be parallel, 20 feet in diameter and 10 feet wide.

HORDEN COLLIERY.

Three shafts are sunk at the apex of each of the angles of a ght-angled triangle, and their centres are respectively 198 feet art. The north and south shafts are 20 feet in finished ameter, and the east shaft is 17 feet in finished diameter.

The north shaft is sunk to the Hutton Seam, at a depth of 260 feet. Sinking was commenced on November 6th, 1900, d was completed on July 22nd, 1904. In this shaft, water is met with at the depth of 198 feet, and from this point down- ard to a depth of 522 feet the shaft is secured with cast-iron bbing. Above and below this section, the shaft is secured with ick-work, 14 inches thick. The shaft passed through the ve-Quarter, Main Coal, Low Main and Hutton seams, all of orkable sections.

The south shaft is sunk to a depth of 621 feet into the Coal- easures, and is, at present, standing until the east shaft is sunk rough the sands lying below the Magnesian Limestone. This aft has 363 feet of cast-iron tubbing fixed therein from a depth 198 feet down to a depth of 561 feet.

The east shaft is sunk to a depth of 480 feet, and has 249 et of cast-iron tubbing fixed therein. There is a depth of 61 et 10 inches of sand to pass through before the Coal-measures e reached in this pit; and, after this work is completed and the eders tubbed back, the whole of the shafts will be absolutely y.

During the last three years, there has been continuous pump- g varying from 3,000 to nearly 10,000 gallons of water per nute, the last-named quantity consisting largely of salt-water, d the former consisting of the fresh-water sand-feeders.

HYLTON COLLIERY.

Hylton colliery is situated on the site of the Wear steel- orks, on the northern bank of the river Wear, about 2 miles ove Sunderland.

Shafts.—There are three shafts: the east, west and south its. The east pit, 20 feet in diameter, is drawing coals from ie Hutton seam, of an average thickness of 4½ feet of clean al, at a depth of 1,580 feet. The west pit, also 20 feet in

diameter, is drawing coals from the Maudlin seam, 5¾ feet thick, at a depth of 1,440 feet. The east and west shafts are downcast pits. The south pit, 15 feet in diameter, sunk to the Hutton seam, is the ventilating or fan-shaft. All the shafts are lined throughout with brick-walling.

Winding-ropes, Pulleys and Cages.—The winding-ropes, of mild steel and Langs lay, are built up of six strands of seventeen wires each; they are 5¼ inches in circumference, weighing about 26 pounds per fathom. The ropes are capped in the ordinary way, with hooped sockets, and riveted.

The pulleys, carried on frames of steel lattice-work, are 20 feet in diameter; they are of German manufacture, the rim being built in segments and carried on the boss by tapered flat spokes.

The cages in the east pit are designed and built for the adoption of a counterbalance-rope. Each cage carries eight tubs, four tubs on each deck: the intervening space, in which the men ride, adapts the cage to the double heapstead and obviates decking. A drawbar, 2½ inches in diameter and made of forged iron, runs through the cage from top to bottom. The cages are built in halves, and the drawbar is inserted before the two sections are bolted together. The winding-rope is attached to the top of the drawbar, and the counterbalance-rope to the bottom. By this arrangement, the extra strain occasioned by the weight of the counterbalance-rope is never applied to the cage, while the keps are never required to carry more than the weight of the cage and its load, the counterbalance-rope always being directly connected to the winding-rope by the drawbar.* Ormerod detaching hooks are in use at the three pits.

Winding-engines.—The engines for winding at the east and west pits are in every way similar: that is to say, they are high-pressure with two cylinders, 34 inches in diameter by 6 feet stroke, and fitted with double-beat valves and automatic cut-off gear. The working pressure of the steam is 120 pounds per square inch. The parallel winding-drums are 20 feet in diameter on the oak cleading, 7 inches thick, fixed upon steel lagging-plates; they are fitted with strap-brakes, worked by a foot-lever, and with powerful steam-brakes.

* "The Adoption of a Balance-rope at Hylton Colliery," by Mr. T. E. Parrington, *Trans. Inst. M.E.*, 1903, vol. xxvi., page 294.

Heapstead and Banking-out Arrangements.—The heapstead is built on brickwork arches, the floor being of steel-girders and concrete laid with a gradient, which allows the tubs on leaving the cages to gravitate to the tipplers, the last-named being worked automatically by an arrangement of levers. As the full tub approaches the tipplers, it drops a lever which liberates the empty tub in the tippler. As the empty tub is pushed clear of the tippler by the full tub coming in, the lever lifts, and the full tub is locked in. From the tipplers, the empty tubs run to the keepers at the back of the shafts, and are raised by them to a level from which they run automatically back to the banksman.

The output of the colliery has, up to the present time, been disposed of as unscreened gas-coal; and the jigging-screens, which have been erected, are not, as yet, in use as screens. All the coal is, however, passed over the picking-belts.

Ventilating Fan.—The Waddle fan, 25 feet in diameter at the blade-tips, is driven direct by a tandem compound engine, with cylinders 18 and 30 inches in diameter by 2 feet stroke. The fan, at present running at 50 revolutions per minute, circulates 200,000 cubic feet of air per minute, at 1 inch of water-gauge.

Air-compressors.—There are three Ingersoll-Sargeant two-stage air-compressors, with steam-cylinders respectively 18 and 30 inches in diameter, and the air-cylinders are 25¼ and 16¼ inches in diameter respectively, by 2 feet stroke. The air leaves the low-pressure cylinder at a pressure of 38 pounds per square inch, and, passing through an intercooler, is compressed to 100 pounds per square inch in the high-pressure cylinder. The air-cylinders are water-jacketed. The air leaves the high-pressure cylinder with a temperature of about 250° Fahr.

Lighting.—The whole of the surface and the shaft-bottoms are electrically lighted, the current being supplied from a Tyne dynamo driven by a Robey engine of 50 horsepower. The output of the dynamo is 400 ampères at 110 volts, at 600 revolutions per minute, being equivalent to 700 lamps of 16 candle-power.

Boilers.—The west battery, consisting of six Lancashire boilers, 30 feet long by 8½ feet in diameter, supplies steam at a

pressure of 120 pounds per square inch. The east battery will also consist of six Lancashire boilers, 30 feet long by 9 feet in diameter. Three boilers are already in use, supplying steam at the same pressure. Each of these boilers is fitted with isolating valves, both at the main steam-jug and at the sludge-pipe.

Haulage.—At the present time, the coals are being dealt with by compressed-air engines, with cylinders 10 inches in diameter by 16 inches stroke, working on the main-and-tail system. When a permanent method of haulage is adopted, these engines will become secondary engines and will be moved farther inbye.

WEARMOUTH COLLIERY.

Wearmouth colliery is situated on the northern bank of the river Wear, near Sunderland, and 1¼ miles from the sea-coast at Roker.

Great difficulty was experienced in sinking the shafts, owing to the occurrence of a considerable thickness of quicksand, near the surface; and further heavy feeders of water were encountered in the fissured Magnesian Limestone: the maximum quantity pumped to the surface being computed at 2,000 gallons per minute. The sinking of the shafts to the Hutton seam extended from 1826 to 1835, so that the difficulties to be overcome must have been very serious.

The A pit, 11½ feet in diameter, is a winding and upcast-shaft. The B pit, 12½ feet in diameter, is placed 100 feet south-west of the former, and is a winding and downcast-shaft. The depth of each shaft to the Hutton seam is 1,723 feet.

The principal coal-seams sunk through are as follow:—

	Thickness of Coal. Ft. Ins.	Depth from Surface. Feet.
Five-Quarter Coal-seam	2 10	1,077
Main Coal-seam	2 11	1,509
Maudlin Coal-seam	5 3	1,605
Low Main Coal-seam	1 4	1,657
Hutton Coal-seam	4 6	1,723

At the Yellow Sands and Magnesian Limestone, the water is excluded by a cast-iron tubbing, about 300 feet in length in each shaft.

The Maudlin and Hutton seams are now being worked. The Maudlin coal has been worked under the sea for a distance of about 3,000 feet.

Methods of Working.—The most general method of working is by bord-and-pillar. The bords are driven 12 feet wide, and the walls 9 feet wide, to such lengths as to form coal-pillars, 120 feet square. The bords and walls are usually driven to a boundary, or a fault, or other limit, and then the working back of the pillars is commenced. It is sometimes found expedient to work the coal by a modified system of longwall, and this is generally the method practised in the Hutton seam.

Ventilation.—The mines are ventilated by furnaces, assisted by the heat given out from 5 multitubular boilers and 4 cylindrical boilers placed underground. The quantity of air in circulation is about 220,000 cubic feet per minute, under a water-gauge of $2\frac{3}{4}$ inches.

Haulage.—Three hauling-engines, placed near the bottom of the pits, are supplied with steam at a pressure of 40 pounds per square inch from the adjacent boilers.

No. 1 engine, in the Hutton seam, near the B Pit, has two horizontal cylinders, 14 inches in diameter by 2 feet stroke, it is geared 2 to 1, and fitted with two drums, 5 feet in diameter and 18 inches wide, adapted for main-and-tail-rope haulage. This engine hauls from four districts, embracing a wide area, extending to 9,000 feet, 9,000 feet, 7,000 feet and 6,000 feet respectively. No. 2 engine hauls from the Maudlin and Hutton seams on the south-western side of the B pit. This engine, with two horizontal cylinders, $22\frac{1}{2}$ inches in diameter by 5 feet stroke, is directly connected to two drums, 6 feet in diameter and 2 feet wide. No. 3 engine, placed near the A pit in the Hutton seam, is of the same dimensions as No. 2 engine.

Winding.—The winding-engine at the A pit is of vertical, lever and condensing type. The cylinder, 61 inches in diameter by 7 feet stroke, is fitted with double-beat valves; and the air-pump is 3 feet 8 inches in diameter. Steam is supplied at a pressure of 30 pounds per square inch, and a vacuum of about

12 pounds per square inch is produced. The over-head flat-rope rolls are placed 4 feet apart. On lifting the load from the bottom, the diameter of the roll is 23½ feet, and, at the end of the wind, the diameter, including ten coils of rope, is increased to 27 feet. The engine is fitted with a counter-balance chain, weighing about 16 tons, working in a staple. The cages carry 6 tubs on 3 decks, each tub carrying 9½ cwts. of coal. The time occupied in raising the load is 70 seconds, and in changing the tubs, 30 seconds. The flat winding-ropes, 5 inches wide by 1 inch thick, are made of patent improved steel. The cages are guided by steel wire-ropes, 3½ inches in circumference, at each corner of the cage: each rope being weighted at the bottom with 2 tons.

The winding-engine at the B pit is of similar construction to the engine at the A pit. The cylinder is 65⅝ inches in diameter by 7 feet stroke. Each cage carries 8 tubs on 4 decks. There are two landings, so that the tubs in two of the decks are changed simultaneously.

At both pits, the headgear is constructed of iron-lattice work, comprising two legs, backstays, intermediate supports and struts.

Boilers.—There are four Lancashire steel boilers at the A pit, each 30 feet in length and 8½ feet in diameter, working at a pressure of 100 pounds per square inch, and this pressure is brought down by a Royle reducing valve to 30 pounds. At the B pit, there are five Lancashire steel boilers, 30 feet long and 8 feet in diameter, worked in the same manner as at the A pit. The height of the boiler-chimneys is 130 feet.

At the upcast-shaft, there are two tall chimneys for the purpose of carrying off the smoke clear of the banksmen.

SEAHAM HARBOUR.

The Seaham Harbour Dock Company, who acquired, from the Marquis of Londonderry, the old docks, built some 70 years ago, are now adding a 10 acres deep-water dock and entrance, and throwing out two protective piers to shelter the approach from the sea. The new works were commenced in the early part of 1899, and it is expected that they will be completed next summer.

In the early stages of the work, considerable difficulty was experienced in enclosing and reclaiming the necessary land required for the new dock and quay-space, as at that time little or no protection was afforded by the piers, which were not far enough advanced. This was, however, eventually done, and the site of the new dock was deepened some 12 feet into the Magnesian Limestone, by the aid of steam-navvies and blasting. The walls of the new dock are constructed of concrete, faced with masonry above water-level and finished off with a coping of Norwegian granite. The walls are 35 feet high, above dock-bottom level, and there will be 27½ feet of water in the dock at high-water of ordinary spring-tides.

The new entrance, constructed of concrete faced with masonry, is 65 feet wide, with a depth of water of 25½ feet on the sill. Two pairs of gates are fitted: the outer, to act as storm-gates, are constructed of karri-wood from Western Australia. The gates will be worked by hydraulic rams fixed in machine-pits at the coping-level, and supplied with power from an hydraulic installation working at a pressure of 700 pounds per square inch. Two 5 tons capstans are fitted at the entrance.

A system of gravity coal-staithes is being fixed along the western side of the new dock, so arranged that the full coal-wagons will run down by gravity from the storage-sidings, pass over the spouts, and the empty wagons will pass away to the low-level sidings. It is anticipated that about 2,000,000 tons of coal will be shipped annually in the dock.

The protective piers are 1,383 feet and 878 feet long, on the north and south sides respectively. They are built up of concrete-blocks, weighing up to 28 tons, faced with masonry. The blocks are formed in moulds in the block-yard, allowed to harden for some six weeks, and then set in position by means of a titan crane, capable of dealing with a load of 30 tons at a radius of 60 feet. The foundations for the piers are on rock throughout. Sand overlies the rock in places and is cleared away by means of a grab and a diving bell. Mass-concrete, put in place by divers, is used to level up the surface of the rock, and the blocks are placed on this, and secured to one another below low-water level, by means of concrete joggle-bags. Above low water, the blocks are set in cement-mortar.

The north pier is 25 and 30 feet wide on the top at its inner and outer ends respectively, and the south pier is 20 and 25 feet wide. The ends will be finished with roundheads and light-houses, with a subway running through the piers to give access to them in stormy weather.

The contractors for the work are Messrs. S. Pearson & Son, Limited, of Westminster, and the contract-price is £378,000.

SUNDERLAND HARBOUR: PROTECTING PIERS.

Roker Pier.—The total length of the Roker pier is 2,800 feet, 2,340 feet of the shore-portion being 35 feet wide; the seaward-portion for 460 feet is 41 feet wide, and the face-walls of the pier are battered 1 in 10.

The structure below low water and up to 2½ feet above low water is formed of 56 and 116 tons bags of concrete (4 of cement to 1 of sand) deposited in a plastic state on the rock. The special Wake twin-screw bag-barge vessel was used for this purpose, with a large and a small box, with half falling doors in the bottom, slung in the well suspended from hydraulic cylinders; and, when deep water was reached, this vessel was lengthened for two large boxes of 116 tons. The boxes were first lined with the bags made of jute-sacking as the vessel lay under the spouts of the concrete mixing-house in the river; when filled they were laced up, and the barge steamed to sea, and was moored over the site where the bag is required; the box was then lowered through the water as near the place of deposit as possible, the doors released and the bag deposited. On the site of the sea-end of the pier, there was a deposit of sand on the rock of varying depths up to 17 feet; and this was removed by a sand-pump dredger before depositing the bags.

The superstructure was built in lengths of 42 feet 7 inches of granite-faced concrete-blocks, varying in weight from 43 to 54 tons, the end of each length having a cross-wall of concrete blocks, and the hearting was filled in with concrete. A subway, formed in the hearting of the pier, for its full length, affords a means of access to the lighthouse in stormy weather. The radial crane used for the block-setting is capable of setting a block, weighing 60 tons, 60 feet in advance of its leading wheels.

The roundhead, formed of an iron caisson, 100 feet long, 69

feet wide and 32 feet deep, was set on a specially prepared foundation of concrete bags levelled to 24 feet below low water. The caisson was floated out with a draught of 22 feet containing 3,500 tons of concrete, sunk on to its site, and filled with concrete *en masse*; block-setting was then started, and the roundhead completed. The total weight of the roundhead is 23,000 tons.

The lighthouse is built in bands of red and grey granite, backed with concrete, the floors and stairs are also of concrete, and the light has a focal plane 83½ feet above high water. The equipment of the lighthouse consists of a third-order quick, single-flashing dioptric light, flashing 0·1 second and eclipsed 4·9 seconds in every 5 seconds. The siren fog-signal gives a blast of 2 seconds' duration in every 20 seconds. Two gas-engines of 7 nominal horsepower with air-compressors deliver 25 cubic feet of compressed air per minute at a pressure of 25 pounds per square inch into an air-receiver in the basement, from which it is conveyed to the sounding receiver on the third floor. The siren, with an automatic sounding valve in a chest of cast-iron on the parapet, has a gunmetal valve and seat with rubber diaphragm, the admission of air being regulated by clock-work, and is self-sounding: the clock being driven by falling weights, and the motor is driven by air from the sounding receiver.

The illuminant was gas, but being at the end of a long main supply and gas-engines being used, the pressure was intermittent. The gas-burner was of 300 candlepower, with an effective flash of 40,000 candlepower; but, as an improvement on the gas-light, the Chance petroleum incandescent-vapour apparatus is now used: the oil-burner giving 1,200 candlepower with an effective flash of 150,000 candlepower.

South Pier.—The mode of building the south pier is much the same as in the case of the Roker pier, but the superstructure differs in detail. The length, when completed, will be 2,844 feet, and there is yet to build 545 feet, leaving an opening between the roundheads of 600 feet. The bagwork is the same as for the Roker pier, but the superstructure is built of 15 tons blocks, and has a parapet-wall, which will be continued for the full length of the pier. A roundhead and lighthouse, similar to

that at Roker, will be provided. The gas-engined crane, used for block-setting, is capable of setting a block, weighing 20 tons, 64 feet in advance of its leading wheels, and can perform a complete revolution.

THE TYNE HARBOUR: NORTH PIER.*

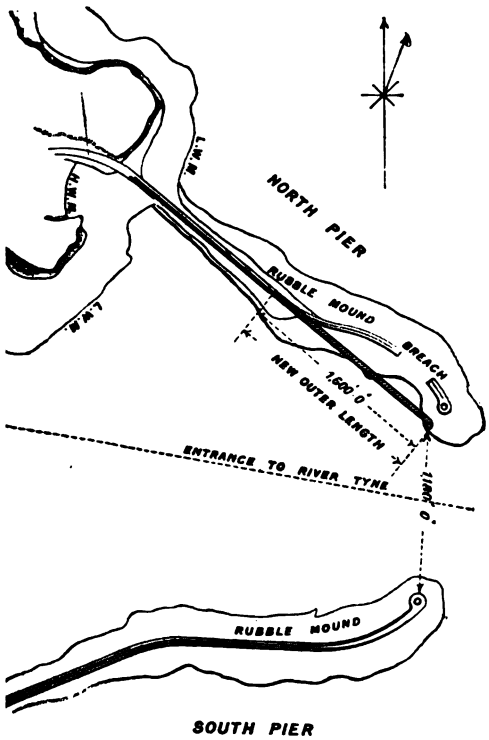
The exposed situation of the entrance to the river Tyne, and the stormy character of the North Sea, as well as the nature of the bottom, rendered the making of the harbour a matter of considerable danger in anything like bad weather. The ugly reefs of rocks that flanked the river-mouth, and the heavy seas running on the shallow bar, were the dread of mariners. It was to overcome these difficulties that forty-seven years ago the extensive masonry-works of the north and south piers were com-

FIG. 1.—THE RECONSTRUCTION OF THE NORTH PIER.

menced, from designs prepared by Messrs. Walker, Burges & Cooper. The piers were carried a considerable distance seaward, thus forming a sheltered entrance to the river, and at the same time adding to the scour, so as to deepen the channel. The south pier has stood, but about five years ago a violent gale caused the sea to make a breach in the north pier; and it was extended by subsequent storms, until the opening was about 300 feet wide. Fig. 1 indicates the nature of the damage.

* Figs. 2, 3 and 4 are reproduced, by permission, from *Engineering*, 1902, vol. lxxiv., page 133.

ıe north pier (Fig. 2) may be divided into two portions: traight part of the shoreward end, and the curved part, ı continues the work seaward and ends with the light--tower. The straight piece was built by contract, Mr. ımin Lawton being the contractor; but the outer portion ɔonstructed by the Tyne Commissioners, their engineer, ıte Mr. P. J. Messent, who had been resident-engineer on ork of the inner part, taking charge of the operations. The superstructure of the pier rests on a mound of rubble-stone, the masonry consisting of two longitudinal walls connected at frequent intervals by cross walls. The pockets thus formed were filled in the shoreward or inner half with quarry-débris, but in the seaward half, mass-concrete was used. At the outer end of the pier, the foundations were carried to a depth of 27 feet below low-water level: a greater depth than had been originally



:.—Plan of the Entrance to the River Tyne. Scale, 1,333 Feet to 1 Inch.

ned, but it was discovered during the progress of the work the effect of wave-motion was of importance at a greater . beneath the surface than had been thought to be the (Fig. 3).

he new structure is to form a continuation of the original ght part of the pier, and will be 1,500 feet in length, so the breakwater, when finished, will be straight from end

to end, and of a total length of about ½ mile. The outer end of the old pier forms a shelter for the new work; but, after the latter is finished, this part of the original construction will be removed, otherwise it might become a source of danger to the new structure. Profiting by experience, the foundations will be carried down to the hard shale, thus doing away with the rubble-mound, which was formerly used. Above low-water level the section is the same as in the original structure (Fig. 4).

The structure is of concrete-blocks, bonded together, the largest weighing from 30 to 40 tons, no mass-work being used below high-water level. The blocks are made at the works on shore, close to the end of the pier, where the necessary plant has been installed, comprizing a rotating concrete-mixer, a

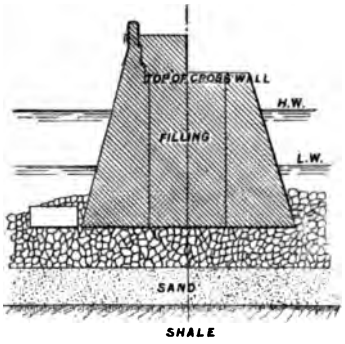


FIG. 3—TYPICAL SECTION OF OLD WORK.

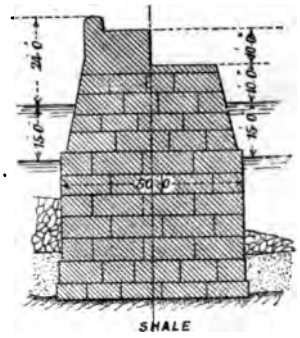


FIG. 4.—TYPICAL SECTION OF NEW WORK.

SCALE, 52 FEET TO 1 INCH.

number of moulds for forming the blocks, and other necessary appliances. The outside surfaces of the blocks, exposed to the sea, are faced with granite-blockers, built into the mould, and the concrete is then run in, so that the whole forms a monolithic mass when set. A half-round recess is formed on each side of the block, and when it is adjusted against a corresponding recess in an adjoining block, on the blocks being erected in position, a circular vertical hole is formed. This hole is filled, when the blocks are set, with a bolster of concrete, which thus locks the blocks together, so that they can have no motion relatively to each other. Above low-water level, the blocks are built with mortar-beds, and the joints are grouted.

A temporary staging of wooden piles, braced together by steel rails, is built on the line of the pier. The railway, by

h the blocks are conveyed, is laid on the staging, and above
s a gantry carrying the powerful goliath cranes, by which
blocks are set in position (Fig. 1).

The bottom, which has to take the foundations, is very care-
r levelled, so that the masonry may rest solid and square on
eating. A grab works ahead and removes all material that
an reach, and the hand-work is done from a diving-bell,
ended from one of the overhead-travellers. The bell, 12
long, 9 feet wide and 6 feet high, allows four men to work
t at once. The bed having been prepared, the blocks are
ered by the goliath cranes, and are set by divers in the usual
ing-dress.

The new work, estimated to have a weight of about 250,000
, is being carried out by the River Tyne Commissioners; the
neers are Sir John Wolfe Barry and Messrs. Coode, Son
Matthews; the resident engineer is Mr. Ivan C. Barling;
the contractors are Sir John Jackson, Limited.

EWCASTLE-UPON-TYNE CORPORATION TRAMWAYS: MANORS POWER-HOUSE.

The coals are delivered by means of an electric locomotive
elf-trimming bunkers. The boiler-house contains twelve
Cashire boilers fitted with mechanical stokers and auto-
c weighing-machines. The pump-house contains two Weir
ps, and an electric pump, all fitted with duplicate steam-
water-connections, stoker-engine and motor.

The engine-house contains an enclosed engine of 800
cated horsepower, two compound engines, each of 1,000
epower, a triple-expansion engine of 2,000 indicated horse-
er, and a triple-expansion engine of 4,000 indicated horse-
er. On the engine-house floor, stand the main traction-
chboard, boosters, motor-generators and balancers, while on
llery at the west end of the house stands the three-wire con-
ous-current lighting-board.

E NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY OMPANY, LIMITED: CARVILLE POWER-STATION.

About twelve years ago, the Newcastle-upon-Tyne Electric
pply Company, Limited, made a modest beginning at Pandon-

dene, where an electric generating station was erected to supply electricity. The demand grew year by year, extra plant was added, and finally, the load grew heavier than the station could bear, and it was found necessary to erect a new station at Neptune-bank.*

This station was planned on a great scale, for it had to supply not only Newcastle but several outlying districts, and notably several of the shipyards and engine-works on Tyneside. These works got into swing in 1901, but fresh plant was put down at such a rate that all the available space was filled, and a still larger station had to be put in hand. This is situated at Carville, and holds now no less than 15,000 horsepower of electric generating plant, but it is so constructed as to be available for very large extensions.

The Carville power-station generates three-phase current at 5,500 volts and 40 cycles, the same as the Neptune-bank station. From the Carville station, feeder-cables are run to the various sub-stations supplying the North Eastern railway, and these sub-stations are interconnected with the older sub-stations for supplying Newcastle-upon-Tyne with power and lighting, and the riverside manufacturers with power. The site of the station is about ½ mile down the river from the Neptune-bank station.

The present capacity of the station is 12,000 kilowatts o 360,000 incandescent lamps, made up by two 2,000 kilowatt and two 4,000 kilowatts Parsons turbo-generators. The alte nators are of the revolving-field type, capable of carrying loa up to 2,500 and 5,000 kilowatts respectively, for 1 hour. Th steam-consumption, at the rated loads of 2,000 kilowatts a 4,000 kilowatts, is guaranteed to be less than 18 pounds p kilowatt for the 4,000 kilowatts sets and 19 pounds per kil watt for the 2,000 kilowatts sets.

The feed-pump suction is ordinarily taken from the hot-wells, but the water-piping system is so arranged that the feed-pumps may draw from four sources of supply, namely:—(1) The hot-wells, (2) the reserve feed-water tank, (3) the town-mains, and (4) the river-water tank.

The reserve feed-water tank is of 30,000 gallons capacity, the river-water tank being about one-tenth of this size. The latter is provided, in order to secure a supply of water should

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 607.

the town-supply fail for any length of time, and in order to provide water over the whole station for cleaning and washing-down purposes. The water-service to the station-buildings forms a ring-main from one tank to the other, so that either supply of water may be used for any particular purpose or for every purpose.

The "make-up" may be taken from the top of the tank or from the bottom, but in order that the engineer may know when the town-supply fails, it is ordinarily taken from a facing about 10 inches below the top-level of the water in the tank. Should his water-supply then fail, the engineer will know that he has at any rate a full reserve-feed tank of water to evaporate before he adopts the alternative of using river-water.

In the turbine-house, the overhead travelling crane can handle any portion of the main or auxiliary machinery, although the condensers and air-pumps are placed on a lower level than the main turbines: this becomes possible, as the engine-house floor, between the turbines, is formed of removable cast-iron gratings.

The condensers are each placed immediately beneath the turbine which they serve, and they are each supplied with supplementary augmentor-condensers, by which the water of the condensed steam and the suspended vapour are taken separately from the condenser-chamber, thus enabling a slightly higher vacuum to be obtained. The air-pumps are of the three-throw type, a plunger pump being fitted on an extension-shaft to each pump for lifting the water from the air-pump discharge to the hot-wells. The air-pump discharge can be diverted from the hot-well to a weighbridge and tank, and by this means the steam-consumption of any generating set can be ascertained at a few moments' notice. The circulating-water for the condensers is obtained from the river Tyne: a pump-house containing two centrifugal circulating pumps being erected on a jetty at the riverside for this purpose. Either of these pumps is sufficient for 8,000 kilowatts of plant, that is to say, a single pump is sufficient for the condensers of two generating sets. The discharge circulating-water main is carried to the river and buried beneath low-water mark, so that advantage of the atmospheric pressure is obtained in lifting the condensing water, the power demanded under these conditions being (theoretically) only that necessary to overcome the friction of the pipes.

The boilers are so arranged as to feed either saturated or superheated steam to the steam-main.

The pumps deliver to a double ring of feed-pipes, with economizers at the other end, so that the feed-water is either hot or cold, according as the water is sent through the economizer or not; but, normally, the economizers are in use.

Coal is taken direct to the bunkers from the railway-siding by means of an electric locomotive and an overhead siding, being conveyed from the bunkers to the stoker-hoppers by automatic weighing apparatus. The ashes are discharged from the boiler-furnaces by automatic doors to a conveyor, which empties them into an ash-bunker, whence the empty coal-trucks can be filled.

The draught is either induced or natural, as may be required, that is to say, induced-draught fans are installed, but a natural-draught bye-pass is provided as a standby, should the fans not be required by the conditions of load.

The boiler-houses lie at right angles to the engine-house, separate chimney being provided for each complete boiler-house. With this arrangement long lengths of steam-piping are avoided, and each battery of boilers is arranged opposite the generating set which it feeds in the turbine-house. The station is thus divided into practically complete and independent sections or units, each section or unit being capable of working independently of its neighbour, and being connected only at three points, namely:—(1) The coal-bunkers, (2) the main omnibus-bars, and (3) the circulating-water system.

The Babcock-and-Wilcox marine type of boilers are of 20,000 pounds per hour normal capacity, but each is capable of evaporating 28,000 pounds of water, if forced. The superheaters impart 150° Fahr. of superheat to the steam. Four boilers are normally sufficient for a single generating unit, the fifth boiler of each section being a spare one, so that it is possible always to have a boiler laid off for cleaning, inspection and repairs.

There are three Woodeson boiler-feed pumps, and each is sufficient for five boilers or one boiler-house section, so that one boiler-feed pump is spare when both the boiler-house sections are in full working.

Throughout the works, no cylinder or steam lubricant of

any kind is used, a fact which should assist the boilers, both from a steaming and maintenance point of view. Steam to the feed-pumps is taken direct from the boilers by a special main as saturated steam, without passing through the superheaters, in order that it may provide its own cylinder-lubricant.

The exhaust from the feed-pumps is taken through a spiral coil in the hot-well, where it is condensed and then led to a drain-tank, into which all the steam-traps also discharge. The water from the drain-tank, including as it does all drain-water and the feed-pump exhaust, is returned by a small centrifugal pump in the hot-wells. There is an overflow from the drain-tank to a bilge-tank, but normally the centrifugal pump is kept running constantly, for the purpose of returning the contents of the tank to the hot-wells, of which there is one to each unit.

ELECTRIC TRACTION ON THE NORTH-EASTERN RAILWAY.

The city of Newcastle-upon-Tyne is situated about 8 miles from the mouth of the river, the intervening districts on both banks being densely populated, and containing an almost continuous succession of shipbuilding yards, and engineering and other works. Between Newcastle and the sea, there is consequently a heavy traffic the whole year round, and this is swelled to enormous proportions during holiday seasons.

The lines which are now electrically equipped for passenger service were previously operated by steam locomotives, with the exception of the line from Gosforth to Ponteland, which is now under construction. The Quayside branch-line, used for goods traffic only, is also being equipped for electrical operation.

The trains are operated by continuous current obtained from a single collector-rail, placed in the 6 feet way, with a return-circuit through the running rails. The current is derived from rotary converters and static transformers, which convert the three-phase current at a pressure of 5,500 volts and periodicity of 40, into continuous current at a pressure of 600 volts.

The collector-rail is of high-conductivity steel, Vignoles section, weighing 80 pounds per yard, carried on insulators composed of reconstructed granite, placed outside the running rail and spaced 3 feet 11½ inches from the centre of the track. On

double track, the separate collector-rails, belonging to each track, are normally placed between the two tracks; but at junctions, crossings, etc., or wherever there is any obstruction in the 6 feet way, the collector-rail is transferred to the outside of the track, as required. At level-crossings, stations, etc., the collector-rail is protected by two creosoted boards, bolted against distance-pieces, placed on each side of the rails. Under normal conditions, the collector-rail has no protection, but holes for fixing this are punched in the collector-rails, so that protecting boards may be readily applied at any point, where such may be deemed desirable.

The collector-rail for the return-current has been economically formed by bonding the running rails, but the position of the single collector-rail has been so fixed that a return collector-rail can be installed between the rails, at any future time, should this prove advisable. As the standard fish-plate did not allow sufficient space between it and the web of the rail to admit of the use of protected bonds, a new fish-plate, giving more room, was designed by Mr. Charles A. Harrison, engineer of the line; and, as the bonding of the track proceeded, all the fish-plates previously in use were replaced by those of the new design.

Current is supplied to the collector-rail from five sub-stations located respectively at Pandon-dene, Wallsend, Cullercoats, Benton and Kenton. Fourteen 800 kilowatts rotary converters are distributed among the various sub-stations. The Pandon-dene sub-station contains four of these rotary converters. These have been specially designed to operate, without serious sparking, at an overload of 100 per cent. for 10 minutes, and at an overload of 200 per cent. momentarily. The main static transformers are of the single-phase, oil-insulated, self-cooling type. A small induction-motor, fed by a special transformer, is coupled to each rotary converter; and the rotary converter is started up by means of the induction-motor until it attains the synchronous speed of the rotary, and then it is switched on to the high-tension omnibus-bars in the usual way.

With the view of simplifying the arrangement of cables and leads inside the sub-station, the high-tension switch-board has been placed on one side of the sub-station, and the low-tension switch-board is placed on the opposite side of the building. On the positive leads are taken to the low-tension switch-board, t

negative omnibus-bar running near the floor, behind the switch-board, and the equalizing switches are placed close to the rotary converters. The high-tension switches are of the oil-type, the feeder switches are provided with an automatic reverse-current release, and the converter switches with an overload time-limit release, all being operated electrically by low-tension continuous current, supplied from a small battery in each sub-station.

High-tension and low-tension watt-meters are provided for measuring the input and output of each sub-station.

The sub-stations receive their supply of three-phase current, at a pressure of 5,500 volts, through three-cored, paper-insulated, lead-covered cables, laid solid in wooden troughs along the railway.

The rolling stock comprizes motor- and trailer-coaches, the bodies being built by the railway company at their works at York, from the designs of Mr. Wilson Worsdell, the chief mechanical engineer. The coaches are of the open-corridor type, lighted and heated by electricity. Each coach is carried on two four-wheeled bogie-trucks. Each motor-coach is equipped with two G. E. 66 motors, each rated at 150 horsepower, both motors being carried on one bogie-truck.

The unit system is composed of two motor-coaches with one trailer-coach between them, this being strengthened when necessary by the addition of another unit train. The motor-coaches have drivers' compartments at one end only, but a master-controller is fitted in the vestibule at the other end also, so that the coach may be driven from this end if necessary.

Beneath each motor-coach are fitted a number of electrically operated switches for making the necessary connections of the motors, and for cutting in and out the resistances, step by step. These switches are actuated by current derived from a nine-wire multiple cable, which runs from end to end of each motor-coach, and is fitted with suitable coupling devices at each end. The trailer-coaches also have a multiple cable, with couplings, running from end to end. In this way, the train when made up, no matter how long, has a continuous nine-wire cable from one end to the other, and by letting current into any wire of this cable at any point in the train, the corresponding electrically operated switches on all of the motor-coaches are simultaneously actuated, and thus the necessary combinations of motors and

resistances are made simultaneously on each of the motor-coaches. The master-controller by which current is introduced into this nine-wire cable at the will of the driver, can be placed wherever desirable. For instance, in addition to a master-controller in the driver's compartment at each end of the train, one may be placed at the other end of each of the motor-coaches, or even on the trailer-coaches, in fact at every place at which there is likely to be any need to control a train. Suitable interlocked handles are provided, so that it is not possible to leave a master-controller in a wrong position or to work two of them simultaneously.

The coaches are fitted with the Westinghouse air-brake, a motor-driven air-compressor being provided for this purpose.

Each motor-coach is provided with four contact-shoes, one at each side of each bogie-truck, to collect the current from the live rail, and the whole of the contact-shoes of each train are connected together so as to avoid the possibility of the train losing its supply of current at junctions, crossings, etc., where the continuity of the third rail must necessarily be broken.

The ordinary stopping train takes about 23 minutes for the journey from Newcastle to Tynemouth, the average speed being about 22 miles per hour, including stops. Quick trains, running through without stops, reduce this time to 15 minutes.

Two electric locomotives will be provided for working the Quay-side branch, and these will be equipped in the same way as the motor-coaches, with a multiple-unit controller, Westinghouse air-brakes, etc. Each locomotive will be capable of starting with and hauling a train, weighing 150 tons, up a gradient of 1 in 27 at a speed of 9 to 10 miles per hour.

The North-eastern Railway Company purchase current from the Newcastle-upon-Tyne Electric Supply Company, Limited. A portion of this current is generated at the Neptune-bank station at Wallsend, but the bulk of the supply is obtained from the Carville station.

NORTH-EASTERN RAILWAY COMPANY: LOCOMOTIVE WORKS, GATESHEAD-UPON-TYNE.

The locomotive, carriage and wagon department employs 18,520 persons.

The Gateshead works occupy a space, including siding-om, of about 30 acres on the south bank of the Tyne. The orks include the following shops:—Fitting and erecting, light-achine, heavy-machine, wheel-lathe, engine-repairing, tank, inding and flanging, boiler, tyre-hooping, tube-brazing, paint-g, brake, joiners' and pattern-makers', tender-erecting and ass-finishers', engine-house, forge and two smiths' shops, brass-undry, tin-shop and store, brass store, iron store, testing-room, emical laboratory and the locomotive running shed.

The engine-house, 45 feet long by 33 feet wide, contains a rtical compound engine, built at Gateshead: steam is tained from six boilers, five being in constant use, whilst one laid off at a time for cleaning. The engine-room also con-ins two air-compressors, which supply air to a number of ceivers distributed in various parts of the works. The com-essed air is utilized for pneumatic drilling and caulking, as ll as for working several pneumatic cranes, each possessing a ting capacity up to 2 tons.

The fitting and erecting shop, 349 feet long and 88 feet wide, ntains two 35 tons rope-driven cranes. There are two lines of ils in this shop, on which engines are both built and repaired. ie output of new locomotives averages between thirty and forty r annum.

The heavy-machine shop is 347 feet long by 90 feet wide. he machining of the engine side-frames is the largest class of ork done; and besides other machines, there is a profile milling achine; a triple-head slotting machine; a drilling machine r boring side-frames; and a radial drilling machine. The illing machines vary in size from the smallest up to those ipable of dealing with work from 8 feet to 10 feet in length. ll the milling cutters, twist-drills, etc., used in the works are ade in this department.

The wheel-lathe shop is 314 feet long by 45 feet wide. The and jib-cranes were put into the building for the purpose of fting the wheels and axles into the various lathes. There are ie usual type of double-headed wheel-lathes, such as are in use 1 all locomotive-works. There are, however, a quartering iachine; a key-way cutting machine; and two crank-axle ithes, one having seven tools, and the other with four tools. 'here are also two hydraulic machines for forcing on and emoving wheels from their axles.

The engine-repairing shop, 280 feet long by 185 feet wide, is served by six rope-driven cranes. A vertical wall-engine drives a small shaft, with light grooved pulleys keyed to it. These pulleys drive the repair-tools. Formerly, the time occupied in hand-boring a pair of cylinders was about 14 days; but consequent on the introduction of these portable boring machines, the time occupied has been reduced to two days. A tool, used for refacing horn-plates, is permanently fixed on a small bogie, and can be run under an engine after the wheels are taken out, put into position, and set to work. A portion of the south bay is fitted up for the purpose of punching and straightening engine- and tender-frames. About 300 engines per annum are repaired.

The boiler-shop is 252 feet long by 61 feet wide. The output of locomotive boilers in 1903 was 100, in addition to a number of stationary boilers.

The forge, and one of the smiths' shops, is contained in a building 441 feet long by 62 feet wide. The forge contains eleven hammers, varying in power from 3 tons down to 5 cwt. The fact that steel castings, in many cases, are used where wrought iron was formerly employed, accounts for the comparatively small sizes of the hammers. The steam-supply to the hammers is furnished from overhead pipes laid along the north wall. The smithy, containing 56 fires, is used for the bulk of the heavier smith's work in connection with locomotive construction. Engine and tender springs are made and repaired in another shop, containing six fires, together with bolts, nuts, rivets, etc., and the smaller class of locomotive work.

The engine painting shop provides accommodation for 18 engines, and is capable of an annual output of over 300 completely painted locomotives.

All samples of steel, iron, gunmetal, copper, wire for ropes, oils, and many other materials for the locomotive and various other departments, are subjected to various tests, chemical and otherwise, in the testing-room and chemical laboratory. The test-house contains a fine 100 tons hydraulic testing machine.

The running shed, 451 feet long by 173 feet wide, contains four turn-tables, and provides accommodation for 80 locomotives.

ORTH-EASTERN RAILWAY COMPANY: HEATON CARRIAGE AND WAGON WORKS AND ELECTRIC-CAR SHEDS.

The Heaton Junction works of the North-eastern Railway mpany are used for the repair and upkeep of all the rolling- ck working in the northern division, including the electric ıches and locomotives, and gear in connection therewith, and › rolley- and barrow-work from Sunderland to Carlisle and eedmouth inclusive.

The extensions comprize a main-lifting shop, 680 feet long 47 feet wide; a carriage-repair shop, 570 feet long by 47 feet de; a machine shop, 110 feet long by 47 feet wide, in which › wheel-lathes, milling machines, engine-lathes, and the usual ls required for the repairing of carriages and electric motors. is shop receives all electric cars for general repairs, the ht repairs being done in the car-sheds adjoining. The rolley op, 110 feet long by 90 feet wide, repairs about 1,200 barrows d 350 rolleys per annum.

The main store, 110 feet long by 45 feet wide, is chiefly voted to spare electrical gear and carriage material. The gon store, 50 feet long by 30 feet wide, is kept separate.

The carriage-painting shop, 520 feet long by 55 feet wide, eives about 800 carriages per annum; the old carriage-lift- shop, 520 feet long by 55 feet wide, will shortly be converted o a wagon-repair and painting shop.

In the wagon shop, the following are all in one line:— ith's shop, 166 feet long by 40 feet wide, and an extension, v being built, of 130 feet; boiler-house, containing one rnish and two Lancashire boilers, 30 feet long by 7½ feet diameter; machine shop, 92 feet long by 40 feet wide; d the wood-machine shop, 81 feet long by 40 feet wide, con- ning a four-cutter planer double-spindle machine, with rotary ters and the usual saws.

The main wagon shop, 370 feet long by 84 feet wide, receives out 7,000 wagons per annum, about 10 per cent. of which quire heavy repairs; and the repair-work includes 40 tons el wagons of the Sheffield-and-Twinberrow and Leeds-Forge oes.

The sub-station, 30 feet long by 20 feet wide, for supplying rent to the works, contains the transformer and switch gear.

The machinery is driven by alternating current—440 volts at 40 ampères.

The wagon shop is still steam-driven, but the whole plant will shortly be converted to electric driving.

The electric car-standing shed, 520 feet long by 200 feet wide, is built with open pits on the tram-shed principle, that is, the main floor is about 4 feet below the running rails, which are placed on balks of timber and brick-pillars. All light repairs, cleaning, and nightly inspections are undertaken in this shed, and 90 cars receive attention, running about 100,000 car-miles per week. The usual stores, offices, etc., adjoin the shed.

NORTH-EASTERN RAILWAY COMPANY: DUNSTON COAL-SHIPPING STAITHES.

Coal-shipments in the North of England are carried out almost without exception from elevated jetties or staithes, either run out at right angles to the river with one or more end-tipping spouts, or parallel to the river, with a series of side-tipping spouts, such as are in existence at the staithes belonging to the North-eastern Railway at Dunston-upon-Tyne. The latter arrangement of side-tipping spouts is undoubtedly the best for rapid shipment, although it entails, as at Dunston, an increased amount of river-frontage, with a proportionately greater quantity of dredging. The existing staithe is 1,709 feet long, being run out from the land into the river and parallel to it by a curve of 396 feet radius.

There are three berths, about 260 feet apart, each berth containing two sets of four, five or six spouts, according to the height of the staithe, the spouts being spaced 87½ feet apart, from centre to centre. The top is laid with three lines of way on an up gradient of 1 in 90, with the necessary points and cross-over roads. The two inside roads are the full ones, up which the coal-trucks are pushed by locomotives to the staithe-head; the coal-trucks are then dropped back by gravitation through the points and down the outside or empty road, tipped down the shoots in batches of about a dozen at a time, and the empty trucks return to the standage. Under ordinary conditions, about forty trucks, each carrying 10½ tons, can be teemed down one spout in an hour, giving an average daily rate, including stoppages, of 4,000 tons per spout-head.

The staithes were originally constructed with the intention of relieving the overcrowded traffic at Tyne Dock, but since their erection, not only has the coal traffic at Tyne Dock considerably increased, but the growth in the traffic at Dunston rendered the staithes quite incapable of coping with the ever-increasing output of the Annfield Plain and West Durham collieries. It was therefore decided in 1897 to double the existing staithes, and thus provide three more berths on the south side, entailing the construction of a dock or tidal basin to accommodate the colliers during shipment. In consequence, the Redheugh branch railway was diverted as far south as possible, then the ground between this line and the new staithes was excavated to a depth of 16 feet below low-water of ordinary spring-tides, that is, to a total depth of 36 feet below the coping-level, having an area at high tide of about 9 acres, with an extreme width of 310 feet. The south and west sides of the basin are battered to a slope of 2 to 1, which is protected above low-water level by a skin of slag or rubble pitching, 12 inches thick, and this is carried down to the level of the clay to secure a solid foundation. A pair of dolphins and mooring-buoys are put down at the toe of the slope, opposite each berth, for empty boats to lie alongside. The entrance of the basin, 93 feet in width, is protected on the south side by a concrete quay-wall, about 1,060 feet long and 41 feet deep (below the coping), and then returns at the east end into an existing quay-wall. The range of tide in the basin is 15 feet, and the coping-level is 5 feet above high-water of ordinary spring-tides. The total quantity of earthwork excavated and dredged to form the dock and the entrance to the same, was over 500,000 cubic yards. The quantity of timber used in the erection of the new staithes was about 250,000 cubic feet. The amount of concrete in the river-wall at the entrance is 17,700 cubic yards, and the quantity of trench-excavation for the same was 28,000 cubic yards.

The new staithes, consisting of a series of frames or trestles spaced 17½ feet apart, and braced together by 12 inches by 6 inches walings and braces, are built upon rows of 13 inches by 13 inches piles, also spaced 17½ feet apart. The super-structure consists of a double row of 13 inches by 14 inches waybeams, placed one above the other, carrying a 3 inches caulked deck,

and a 14 inches by 6½ inches rail-beam under each running rail. Opposite the spouts, where the points and crossings occur, there is a solid 6½ inches deck, instead of the rail-beam. The permanent way, as on the standage lines, is of the company's 90 pounds bull-headed type, with chairs, and consists of two lines of way, broadening out to three at the first set of spouts, and increasing to four at the top spouts, and, at each berth, there is a nest of crossings connecting the full lines with the empty road over the shoots, which are similar in number and position to those already described on the existing staithes. The insides of the spouts are plated with ¼ inch steel-sheeting.

NORTH-EASTERN RAILWAY COMPANY: NEW HIGH-LEVEL BRIDGE.

On the south side of the new high-level bridge, the members saw the progress of the masonry-work in connection with the approaches to the bridge, the south pier in course of erection above high-water, the centre pier about the level of the river, and, at the north pier, the excavation being carried out within the caisson. They also inspected the approach to the bridge through the Forth goods warehouse, being constructed both in brickwork and steel.

CONSETT IRON COMPANY, LIMITED: CONSETT IRON WORKS.

The Consett Iron Company, Limited, at the present time owns eleven collieries, extending over an area of 13,000 acres and producing annually about 1,500,000 tons of coal. There are also about 1,050 coke-ovens, producing about 600,000 tons of coke per annum.

Blast-furnaces.—There are seven blast-furnaces (six of which at the date of the visit were in blast), each 55 feet high, the hearths being 9 feet in diameter; the height to the top of the bosh, 20 feet; and the diameter of the bosh, 20 feet. Each furnace is equipped with three Cowper stoves, varying from 65 to 90 feet in height, and from 21 to 24 feet in diameter.

The blowing-engines are both of the beam and vertical-tandem types. The beam-engines have steam-cylinders, 50

ches in diameter, and blowing cylinders, 100 inches in dia-eter, by 9 feet stroke, designed for a blast-pressure of 5 pounds r square inch. The vertical-tandem engines have steam-ylinders, 50 inches in diameter, and blowing-cylinders, 100 nches in diameter, by 5 feet stroke, designed for a working pres-ure of 10 pounds, but in case of emergency they can work at 15 ounds per square inch.

The steam is raised in Lancashire and Babcock-and-Wilcox oilers by the waste-gases from the furnaces.

Steel-works.—Two melting-shops supply ingots for the manu-ture of steel plates. The east shop contains six Siemens open-rth furnaces of 35 tons, and three of 28 tons capacity. In west shop, there are nine furnaces of 20 tons, one of 28 tons one of 35 tons capacity.

Two cogging-mills deal with these ingots: one a 28 inches driven from the No. 2 plate-mill engine, through steel el-gearing; and the other a 45 inches mill, driven by an ine with two coupled non-condensing high-pressure direct-ng cylinders.

There are four plate-mills for rolling steel plates, two of ch are continuous running, with rolls 6¼ feet long and 25 es in diameter; and the other two are reversing mills, one of ch has rolls 7 feet long and 25 inches in diameter, and the r 8 feet long by 28 inches in diameter. The output of these mills is 3,000 tons per week of plates for boiler, ship and ge building, and general engineering work (including quered plates).

The company also produces angles, bars, etc., the ingots g made at a third steel-melting shop, with seven open-hearth l-melting furnaces of 28 tons capacity. These ingots are ged into blooms, in a cogging-mill with rolls 45 inches in meter, driven by a reversing high-pressure non-condensing ine, with two cylinders, 45 inches in diameter and 5 feet oke.

In front of this mill is a powerful bloom-shear, from which e bloom is carried on live rollers to the large angle-mill, with olls 32 inches in diameter, driven by a reversing high-pressure ngine, with cylinders 54 inches in diameter and 4½ feet stroke.

In close proximity are two other mills, with rolls 22 inches

and 12 inches in diameter respectively. This plant is arranged for the production of angles, tees, zeds, channels, etc., and of round and square bars for shipbuilding and other constructional purposes; and is equal to a production of 2,000 tons per week.

The works include the usual shops for general repair-work; a foundry fully equipped, making 200 tons of castings per week; and a brickworks, capable of turning out 120,000 fire bricks per week, the kilns of which are fired by the waste-heat from coke-ovens, which afterwards passes under the drying floor of the moulding shed.

All the steel is made at the works by the Siemens acid process.

The Consett Iron Company, Limited, owns hæmatite-mines in Spain, and limestone-quarries in Weardale.

The total number of men employed by the company is over 8,000, and the average amount paid weekly in wages is £12,000.

MESSRS. JOHN SPENCER & SONS, LIMITED: NEWBURN-UPON-TYNE.

The firm was established in 1810 by Mr. John Spencer, who commenced business in that year as a maker of files. Subsequently, the firm settled at Newburn, and there laid down a converting furnace, crucible cast-steel melting holes, a rolling mill driven by the water from the burn, and file-shops, together with a tilt-hammer driven also by water-power. From this small beginning, the works have gradually and steadily grown, until they now cover an area of over 60 acres, and give regular and constant employment to about 1,500 men and boys.

Adjacent to the old furnaces, erected for the making of steel by the cementation-process, are the No. 1 rolling-mills, originally driven by a water-wheel (still in position), but subsequently in 1845 driven by a steam-engine, said to have been the first applied to the direct driving of a rolling-mill. In this mill, steel-bars for springs, files, etc., are rolled.

Closely adjoining are the file-shops, where files are cut both by hand and machine; and the spring shops and smith's shop, where every description of laminated, volute and spiral springs are made, for use in railway rolling stock, gun-carriages, safety-valves, etc., together with buffers for locomotive engines, carriages and wagons.

The forge, in addition to the several steam-hammers, contains a 2,000 tons hydraulic forging press, whereby crank- and line-shafting, gun-tubes and other forgings of the largest size are made, in addition to locomotive crank and plain axles, steel cylinder-liners and other important engine-details.

In the steel-foundry, crucible and Siemens-Martin steel castings are produced up to 35 or 40 tons in weight. Steel castings now successfully replace the expensive forgings previously used for many purposes, cast-steel being used for the wheel-centres of locomotives in place of wrought-iron, and for making gearing, wagon-wheels, tub-wheels and every variety of castings.

Adjoining the steel-foundry is a small cast-iron foundry used solely for the making of ingot-moulds, moulding boxes, and such like tools and appliances.

The machine shop is fitted with tools of the largest size, (including a powerful quadruple-geared lathe, and a large boring machine for trepanning hollow shafting of the longest lengths made), chiefly used for the machining of marine cranks and line-shafting, locomotive crank axles, stern-posts, etc.

The rolling-mills comprise steel-melting and re-heating furnaces, cogging-mills, plate-mills and bar-mills, and all the supplementary plant and machinery required for the full equipment of such an establishment. Steel plates, for boiler making and other purposes, over 12 feet wide and up to any weight, can be turned out by the plate-mill, which is capable of making 1,200 to 1,500 tons of plates per week. The bar-mills roll all descriptions of bars. The large cogging-plant is capable of rolling and cutting, at one heat, slabs 60 inches wide and 13 inches thick, ready to be still further rolled down into plates of any desired thickness.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED: ELSWICK WORKS.

Engine-works.—In the bridge-yard several large hydraulic cranes were under manufacture.

In the fitting and erecting shops, the work in hand consisted of hydraulic engines for training the 12 inches and 9·2 inches gun-mountings for several battleships and cruisers, large pumping-plant for deck purposes, and smaller machines for generating hydraulic power on board ship.

In the next shop, some large cylinders and rams for the hydraulic control of dock-gates were being machined and erected. A large number of cylinders, flywheels, and other engine details keep the remainder of the machines constantly busy.

In the forge, the only portion seen was a rolling-mill in which Elswick bronze bar was being rolled from ingots cast in the brass-foundry at Scotswood.

A boiler-house and another erecting yard were passed, on the way from the engine-works to the ordnance department.

Ordnance Department.—The first shop is devoted to turning the various barrels for the larger guns, such as the 12 inches and 9·2 inches. Some of the latest pattern 50 calibre guns were under construction for the Government. These tubes, in some cases 40 and 50 feet long, must be finished correctly to within 0·001 inch. This work, in consequence, is of a very delicate nature, and requires long experience and highly-skilled labour.

There are a number of rifling machines for cutting out the variously-shaped grooves in the bore of the gun, which give the shot the rotation necessary to secure accuracy of aim.

The cradles, which are required to carry the gun, so as to allow of its most efficient working and to take up the shock of the recoil, are also made here. They are so arranged that, when the gun is at rest, they can turn round a small fulcrum resting on a spring. When, however, the gun recoils the spring gives way, and a sufficiently large bearing surface comes into play. By means of this device, a gun weighing 28 tons can with ease be raised and lowered by hand. The recoil is taken up by a piston working in an hydraulic cylinder. Along this, a valve-key passing through a port in the piston is placed and so constructed that the force exerted throughout the period of recoil is practically uniform. A great saving in weight is the result.

In the following shops, the work was of a much smaller nature, including the vast number of hydraulic fittings, which act as the veins of a large gun-mounting, and which enable it to be controlled with much ease and precision. Further on, milling cutters, made from the firm's high-speed tool-steel, were being milled into shape, together with the great variety of taps and drills required for use in the works.

A row of automatic machines, turning out bolts, nuts and other repetition-work, proved of much interest. Downstairs, in contrast to the large guns seen a short while before, Morris tubes were being bored and rifled.

Several Elswick submerged torpedo-tubes were shown in a state nearing completion, and a very fair idea could be obtained of their working.

In another large gun-shop, a large rifling machine was seen at work on a 12 inches gun. Farther on, under the same roof, the largest naval gun-mountings are erected. These consist of an armoured gun-house, an engine-room beneath, and an ammunition-passage, which extends to the bottom of the ship. To allow of their completion in the shop, wells 40 feet deep have been dug in the floor. The mountings, now in hand, will carry two 12 inches guns, are working by hydraulic machinery, and weigh 420 tons. They are for H.M. ships Commonwealth and Hindustan.

Passing through one of the fitting galleries, the visitors entered the shop in which the 12 inches cradles are built. Two were shown lying in readiness to be placed in these mountings.

After a walk through the cartridge-case factory, the party entered a large machining and erecting shop. Almost one hundred 9·2 inches and 6 inches mountings were being constructed.

The main store, a large new building, was quickly passed and No. 5 shop reached. A 6 inches disappearing mounting built at the Armstrong works in Pozzuoli, Italy, was seen lying, and a large number of milling machines used for manufacturing breech-mechanisms were at work.

A number of finished guns ready for delivery were inspected in another shop. The ease and quickness with which the breech was opened, requiring only one movement of the hand, was very striking.

The wiring of the guns with steel-tape called for notice on the way into the steel-works. The tour here was restricted to a walk through one level. A large jacket for a 12 inches gun was being turned in a furnace preparatory to forging. The press for this purpose can exert a pressure of 5,500 tons.

Machines for rough boring and turning the ingots and gun-forgings were also to be seen.

Shipyard.—Another party walked round the shipyard. A battleship for Japan, a first-class cruiser for the British Government, and two scouts, the new type of ship at present being introduced into the Navy, were being built.

At the wharfs were H.M. cruisers Hampshire and Amethyst, of which the latter is the first cruiser to be fitted with turbine-engines.

MESSRS. R. & W. HAWTHORN, LESLIE & COMPANY, LIMITED: NEWCASTLE-UPON-TYNE.

St. Peter's Works.—The members were shown through the machine, fitting and boiler shops. In the erecting shop, they saw the engines for H.M. first-class cruiser, the Duke of Edinburgh, of 23,500 horsepower, and, in various stages of construction, the engines for H.M. scouts, Adventure and Attentive, each of 16,000 horsepower, together with various details for three torpedo-boat destroyers, each of 7,000 horsepower, also building for H.M. Government. Water-tube boilers of the Yarrow type, together with cylindrical boilers, were seen in various stages of construction.

Forth Banks Works.—The visitors saw some locomotives for South America, some for a Kentish railway, some for Government dock-yards, and others; and also water-tube boilers for various war-vessels for H.M. Government and foreign powers.

NORTH-EASTERN MARINE ENGINEERING COMPANY, LIMITED: SUNDERLAND.

The Sunderland engine-works are situated on the eastern side of the South Docks. The buildings comprize engine-shops, boiler-shops, smiths' forge, iron-foundry, pattern-shops, brass-foundry, brass-finishing department, coppersmiths' shop, and other departments. The whole of the machinery is driven by three-phase alternating motors, the current being supplied by the Sunderland Corporation at their generators some 3 miles away, at a pressure of 5,500 volts, and transformed at the company's sub-station to a pressure of 220 volts: the transforming-house and the main switch-house are of the most complete description.

There are about 25 motors, varying in size from 15 to 75 horsepower, the main lines of shafting being split up so that the motors driving these are duplicates, and special motors are fitted for driving the larger and more powerful machines. The overhead travelling cranes are also electrically driven, each crane having three independent motors, and the 60 tons cranes having an auxiliary light lift.

The iron-foundry is equipped for making the largest and heaviest class of marine-engine castings, a special feature being the large pits used for casting propellers.

The machinery in the boiler-shops is exceptionally large, and of the most modern description. The new bay, 240 feet long by 62 feet wide, has an entire glass roof, so that the shops are exceptionally well lighted. The artificial lighting is entirely electrical, and is probably one of the largest installations of lighting on the three-phase system in the kingdom.

NORTH-EASTERN MARINE ENGINEERING COMPANY, LIMITED: WALLSEND-UPON-TYNE.

The Wallsend works were built in 1882, and consist of a symmetrically arranged block of brick buildings. The company have their own forge, iron- and brass-foundries, brass-finishers' and coppersmith's shops, pattern-shop, etc.

The whole of the machinery in the works, including some 20 overhead cranes, varying from 5 to 100 tons, the 100 tons sheer-legs, and 25 tons jib-crane on the quay, are driven electrically on the continuous-current system at a pressure of 250 volts.

There are about 100 motors, ranging from 5 to 50 horsepower each, the total horsepower aggregating about 1,500. The power is taken from a public supply-company, who transmit the current from their Carville power-station, Wallsend (1 mile distant) to the sub-station adjoining the works, where it is converted from three-phase at 6,000 volts to continuous current at 250 volts.

The area of the property, including the foremen's villas and workmen's houses (which belong to the company and were built for the convenience of their workmen) is about 30 acres.

The company, since its formation, has engined about 1,600 merchant and war vessels.

The main shops have lofty bays, over 500 feet long by 60 feet wide. They are fitted with overhead cranes, travelling the whole length of the shops, driven by three and four motors, and capable of lifting up to 100 tons. The tools include lathes of the largest description for shafting work, large boring mills, and horizontal and wall planing machines: all being capable of dealing with the largest class of marine work.

The pattern-shop, a detached building to the south of the iron-foundry, is fitted with the latest types of wood-working machinery.

The river-frontage is over 1,000 feet long, and to enable vessels of the largest tonnage to lie afloat whilst receiving their machinery, there is a substantial jetty for the whole length of the frontage, while on the quay there is a pair of 100 tons electrically-driven sheer-legs, and also a 25 tons electrically-driven travelling jib-crane.

MESSRS. PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED: JARROW-UPON-TYNE.

The works cover an area of about 100 acres, and have river-frontage of nearly ¾ of a mile. They consist of a shipbuilding yard, graving dock and slipway, engine- and boiler-works, steel-works and blast-furnaces, and include within themselves the entire range of operations from the smelting of the ore to the complete equipment of the vessel. There are about 8 miles of railway within the works, which are connected by private lines with the North-eastern Railway.

In addition to numerous electrically-driven modern machines and tools, hydraulic presses, pneumatic riveters and caulkers, electric drills, etc., the shipyard possesses its own forge and also rivet-works capable of supplying the shipyard and boiler-shops. There are also large fitters', plumbers', joiners' and cabinet-makers' shops, where the internal fittings required in ship-construction, including steering gears, etc., are manufactured. The graving dock is 440 feet long by 70 feet wide, and some notable repairs to vessels have been executed in it.

The engine-works is self-contained, having its own forge and also foundries for the production of iron, brass and steel castings. Among the various machines in these shops are a plate

e-planing machine capable of taking a plate 35 feet long by feet wide and planing two edges simultaneously; a set of :ical rolls, capable of bending cold a shell-plate 12 feet wide 1⅝ inches thick; a 200 tons hydraulic flanger; and a hydraulic :ting machine with a 12 feet gap, and capable of exerting a sure of 150 tons. The shops are also equipped for dealing h the Express type of water-tube boiler, and more recently a at for the manufacture of Belleville boilers has been added. peciality is the manufacture of the Reed water-tube boiler, ch has been adopted in the high-speed Jarrow boats and in els constructed for the Admiralty on the Clyde. Nearly 25 es of tubes are used in the manufacture of the boilers and chinery of each 30 knots destroyer.

A feature in the iron-foundry is the manufacture of ingot-lds and slag-tubs.

In the machine and erecting shops, the tools are of the most lern type. In the lower erecting shops, engines of various s for single and twin-screw merchant vessels are built; while he upper shop, torpedo-destroyer engines to run about 400 olutions per minute are erected side by side with engines 18,000 horsepower. For lifting machinery and boilers on rd, a new set of sheer-legs to lift 120 tons has recently been ted.

In the pig-iron making department, there are five blast-aces with the usual equipment of hot-blast stoves. One of e furnaces is set apart for the manufacture of Cleveland iron, cipally for foundry-purposes, and produces about 650 tons week. In the other furnaces, high-class hæmatite-pig is pro-d for the manufacture of the mild steel now so largely used hipbuilding, and about 1,000 tons per week are produced per ace. The furnaces are about 80 feet high, 24 feet in dia-er at the boshes and 11 feet in the hearth. The bulk of the matite-pig produced is converted into Siemens-Martin mild by the acid process, the surplus iron being sold to neighbour-steel-makers. In the steel-works, there are eight melting aces, one of 50 tons and seven of 40 tons capacity per charge. various mills—cogging, sectional, plate and sheet mills—fully equipped with the usual guillotine shears, hot and cold , and contrivances for saving heat and labour.

There is a complete installation of electric power for driving

all the outlying machinery, and also an extensive plant for electro-galvanizing.

The total number of vessels completed at these works since their establishment in 1852 is 776 and the tonnage has risen from 920 in 1852 to 61,016 in 1903. The number of men and boys employed is about 10,000.

MESSRS. ROBERT STEPHENSON & COMPANY, LIMITED: HEBBURN-UPON-TYNE.

At the north-eastern corner of the yard of Messrs. Robert Stephenson and Company, Limited, at Hebburn is situated the largest and most up-to-date graving-dock on the east coast of England and Scotland. This large dock, which has taken over 4 years to construct, is made of concrete, 700 feet long on the floor from the inside of the caisson, 90 feet wide at the bottom and 111 feet wide at the coping. The entrance is closed by a large steel sliding caisson made by the owners. The caisson has keels of greenheart, sliding on polished granite-faces, and is pulled backward and forward by a powerful hydraulic engine. At the entrance to the dock and at the head are placed one 6 tons hydraulic and two 10 tons capstans, to facilitate the warping of ships in and out of the dock. The keel-blocks, as in Admiralty practice, are of English oak, with a view to the docking of large Government ships. The entrance, 90 feet wide, has 28½ feet of water on the sill at ordinary spring-tides.

To the west of the entrance is the pump, power-house, fitting-shops and the boiler-house. The boiler-house contains four large single-ended marine-type boilers working at a pressure of 200 pounds per square inch. The coal is deposited at the boilers with the minimum of handling. The main pumps, which work the dock, are of centrifugal type, worked by compound engines. The discs of the pumps are 6 feet in diameter, and the water-branches are 45 inches in diameter. The pumps and engines are in duplicate, and together can discharge 61,500 tons of water in 3 hours. In addition to the main pumps, there is a centrifugal drainage pump, 10 inches in diameter, and a pulsometer, 6 inches in diameter.

In the pump-house, to deal with the large amount of hydraulic machinery about the dock, yard and boiler-shop, two

large hydraulic accumulators are fitted, with plungers, 15 inches in diameter, also 2 sets of powerful pumping-engines. These develop a pressure in the mains of 1,500 pounds per square inch.

In connection with the pump and power-installation, there is a large marine condenser with 5,000 square feet of cooling surface, one set of Edwards air-pumps, a 40 inches circulating pump, a pair of Weir feed-pumps, and a feed-water heater and oil-separator.

In the power-house are two sets of triple expansion-engines driving two large Westinghouse dynamos, each developing about 650 horsepower at 250 volts. Room has also been left for extensions of the power-plant. Spanning the pump and power-house is a 10 tons crane, with a span of 60 feet.

The fitting-shop, adjoining the power-house, is being fitted up with large lathes, planing and drilling machines, etc., all electrically driven, to undertake repairs to any ship requiring such. Room has been left round the dock to run a large travelling crane with a span sufficient to plumb the dock-centre.

The pump, power, boiler-house and fitting-shops are of large size and are built of wrought-steel joists, columns and girders covered with corrugated steel. Large windows are arranged in the roofs and sides so as to let in as much light as possible. The base of the buildings, for 5 feet upward, is composed of brick-work.

The shipbuilding yard, covering about 40 acres, has been laid out in the most modern fashion, to deal with vessels of the largest size. The river-frontage is about 1,375 feet long, and has numerous fitting-out jetties, dolphins and quays. The four eastern berths are suitable for vessels 700 feet long, and the four western berths range from 350 to 500 feet long. A large gantry is placed between the two berths next the dock. This gantry, about 950 feet long and with a height of 90 feet at the river-end, is composed of massive steel columns and trusses and carries a line of rails on the top. Running on the rails and spanning the two berths is a powerful electric crane, having a span of 178 feet and capable of lifting 3 tons at the extreme end and 10 tons 50 feet out, depositing its burden anywhere within the length of the gantry and its own span.

At the head of the dock is a new plater's shed covering an area of 285 feet by 240 feet, containing shipbuilding

hinery of the most modern type, including 30 feet bending
ls, a 30 feet flanging machine, a 30 feet planing machine,
ree hydraulic manhole punches, scarphing machines, hydraulic
annel cutters, double beam benders, cold saw, hydraulic
ggling and cressing machine, punching machines, capable of
punching holes 2 inches in diameter through a steel plate
inches thick, and shearing machines capable of shearing thi
thickness, double-frame furnace and bending blocks, plate
furnaces, scrive board, etc. All the large machines are serve
with 3 tons and 4 tons hydraulic cranes of large span. In th
shed, as throughout the yard, the machinery is worked either
electrically or hydraulically. Nearly all the machinery is drive
by separate motors.

To the south of this shed and served by three lines of rails
connected with the North-eastern Railway is the stacking
ground for plates and angles. This is an area of about 700 feet
by 320 feet, and is commanded nearly throughout by a large
electrically-driven stacking-crane, running on two pairs of rails,
separate from the rails for traffic. This crane has a jib-span of
285 feet, and can lift a load of 5 tons at its extreme end, depositing
it where required, or lift it on to the platers' barrows at the
top of the shed.

Lines of rails are carried throughout the yard, and one of
these runs down to the river-side on the west side of the yard
where a pair of massive sheer-legs are situated, capable of lift-
ing weights up to 100 tons.

In the older part of the yard are large saw-mills, a riggers'
loft, a joiners' shop, a polishing shop, a model-makers' shop, a
large moulding loft and timber- and pattern-stores.

In brick buildings are situated a large blacksmith's shop
with steam-hammers, a finishing shop, a fitting shop, paint-shop
and large general store.

Another large platers' shed is situated in the old yard, having
punching and shearing machines, bending rolls, mast rolls, a
multiple punching machine, a plate-furnace, frame-furnaces
scrive boards, etc. All the machinery is electrically driven, an
electric winches are also fitted at the bow of each ship.

The boiler-shop is constructed in two bays, each 175 f
long by 45 feet wide, situated at the west side of the yard
within easy access of the river and sheer-legs. At the n

nd of the shop, a large plate-furnace is built, capable of taking ı plates up to 12 feet in width, and in close proximity to this, is furnace for annealing boiler-furnaces, the flues of each furnace ading to one brick chimney.

The machinery inside the shop is constructed for dealing ith the heaviest class of boilers, and consists of a powerful ydraulic press for boiler-end plates, furnace-mouths, etc.; a rge hydraulic riveter for closing shell-ends, etc.; a large plate-lge planing machine; and punching and shearing machines, rilling, tapping, screwing and hole-cutting machines, arranged ı small groups and driven by motors. Each bay is fitted with verhead cranes, capable of dealing with the heaviest boilers ıat are being built in Admiralty and mercantile practice, and ır working pressures up to 210 pounds per square inch.

All the yard, yard-buildings and offices are fitted throughout ith electric light.

The new offices, a handsome building of pressed brick, con-ın dining-room for officials, directors' rooms, waiting-rooms, ıtrance-hall, general office, telephone-rooms, officials' rooms, pewriting rooms, plan-safes, cloak-rooms and lavatories, board-ıom, general drawing office, designing office, caretaker's ouse, etc.

ESSRS. SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED: WALKER AND WALLSEND.

The works are situated at Walker and Wallsend, and occupy ıme 78 acres of land with a river-frontage of about 4,200 feet. here are 16 slips for building vessels, the greatest length being)0 feet. There is also a yard for building large floating docks. he engineering department includes modern machine-, fitting-, ıd erecting-shops and also boiler-works. The dry-dock depart-ent contains two pontoon floating docks to lift vessels up to 50 feet in length, and a dry dock, 550 feet long and 76 feet ide at the entrance.

Besides the usual equipment of heavy machinery in the ıipyards, there is a recent installation of electric power for iving machinery and lighting the works, and also of extensive ydraulic and pneumatic plant.

A noticeable feature of the works is the immense glass-ofed sheds covering four of the berths. The largest of these

ds is 740 feet long, with a clear inside width of 100 feet a[illegible]
height of 144 feet. All the building sheds are equipped wit[illegible]
merous overhead electric cranes. Under one of the she[illegible]
being built one of the two great mail-steamers recent[illegible]
ordered by the Cunard Company, under their contract with th[illegible]
British Government, and designed to be the fastest vessels in th[illegible]
Atlantic trade and by far the largest in the world. The dime[illegible]
sions of each will be about 800 feet long with a beam of 88 fe[illegible]
and 32,000 gross registered tons. Steam-turbines will be us[illegible]
for propelling the vessels, and they are to be of sufficient pow[illegible]
to drive the ships at an average service-speed of 25 knots an hou[illegible]

MESSRS. HAGGIE BROTHERS, LIMITED: GATE[illegible]
HEAD-UPON-TYNE.

The wire-drawing mills are capable of working from a r[illegible]d
½ inch in diameter down to wire of No. 36 gauge with a d[illegible]
meter of 0·007 inch, and the operations extend from the ma[illegible]
facture of the wire out of the rough steel rod, with temp[illegible]
ranging from 0·10 to 0·80 per cent. of carbon, to the turning [illegible]
of finished cables, weighing upwards of 50 tons, in one sin[illegible]
length.

The wire-making department comprizes annealing, temp[illegible]
ing, patenting and cleaning shops.

In the galvanizing shops, all kinds of wire and all clas[illegible]
of ships' ironwork, etc., are galvanized.

In the strand and rope spinning works, all descriptions [illegible]
ropes are manufactured, including galvanized wire-rope [illegible]
ships' standing and running riggings; flexible galvanized ste[illegible]
wire hawsers to Lloyds and Admiralty tests for the towing a[illegible]
mooring of vessels; improved steel-ropes for steam-ploughin[illegible]
round and flat improved patent and improved plough-steel win[illegible]
ing and haulage ropes for mines; extra-flexible hoisting ropes;
galvanized-wire strand for fencing and signal cords; lightning
conductors; picture cords, sash lines, etc.

Electric motors, gas-engines and steam-power are utilized
for producing the requisite motive power used in the works.
The works can carry on the trade in every detail, from the
[illegible] of the pig-iron to the production of the larges
[illegible],000 and 3,300 feet in length a[illegible]

measuring $6\frac{3}{4}$ inches in circumference; underground endless-haulage ropes $1\frac{5}{16}$ inches in diameter and between 6 and 7 miles in length; and tramway ropes, 30,000 feet long by $3\frac{5}{8}$ inches in circumference, in one length, weighing 32 tons. The works are capable of producing 3,500 to 4,000 tons of finished wire and 4,500 to 5,000 tons of wire-rope per annum, and about 500 men and women are employed.

MESSRS. HOLZAPFELS COMPOSITIONS COMPANY, LIMITED: FELLING-UPON-TYNE.

The works are situated at Felling-upon-Tyne, about $2\frac{1}{2}$ miles below the Newcastle swing-bridge. The works consist of about a dozen different buildings, all of which have been newly built, after the property had been thoroughly drained and the lower portions of it buttressed against danger of subsidence. The chemical works, 165 feet long by 79 feet wide, produce various preparations of mercury, copper, etc., used in anti-fouling compositions.

Below a warehouse, 150 feet long and 100 feet wide, are tanks containing the large stocks of varnishes, which are used in the manufacture of compositions, and on the first floor are offices, etc. In the varnish-house, the varnish is made in several boilers containing each from 7 to 10 tons. The varnish boilers are heated by steam-coils and steam-jackets. Immediately the varnish is made, it is run direct into the storage-tanks by a service of pipes leading to the basement of the warehouse. The next building, 111 feet long by 74 feet wide, is the colour-mill, in which the colours are ground in large steel cylinders containing steel balls. After having been so ground, the colours are levigated, passed through a filter-press, and dried in drying chambers. Immediately beyond the colour-mill is the tinsmiths' shop, 148 feet in length by 32 feet in width, in which tins and drums are made. There is a large number of labour-saving machines, which are driven by a gas-engine. There are three large mixing houses, together 195 feet long and 75 feet wide, built in three stories, the upper storey being level with the floor of the general warehouse, and connected with the same by rails, so that the goods from the warehouse may be brought direct to this floor, where they are emptied down funnels into mixing

cylinders standing on the first floor of the mixing houses. These cylinders reduce the constituents of the various compositions into an impalpably fine liquid. From the cylinders, the composition is allowed to empty itself into the mixing tanks, of which there are about one hundred, each capable of containing 2 tons. On the same floor, a line of rails leads to the jetty, from which goods can be loaded into barges by two overhead cranes, or lifted straight up to the higher level and put into railway trucks.

The gas-plant is capable of producing power-gas up to 50 horsepower, at a cost of considerably under 1d. per 1,000 cubic feet; small bituminous coal is used for producing the gas.

The works are lighted by electricity.

LLOYD'S PROVING-HOUSE, SUNDERLAND.

Lloyd's Proving-house, licensed by the Board of Trade for the testing of chains, cable-chains and anchors, was erected by the River Wear Commissioners in 1874, and was owned by them until 1901, when the present company took it over.

The machinery is capable of testing chains and chain-cables up to 2⅞ inches in diameter, and of anchors up to 6 tons in weight: the power of the three testing-machines being respectively, 150 tons, 101½ tons and 75 tons. The 150 tons machine is used for testing the sample of three links taken out of each 90 feet or less of cable, and also for experimental purposes. The 101½ tons machine is used for applying the proof-test to the whole chain, in lengths not exceeding 90 feet. The 75 tons machine is used for applying the proof-stain to anchors. The testing machines, shears, cranes, etc., are worked from an hydraulic accumulator at a pressure of 2,000 pounds per square inch.

The examination of the articles tested is done by electric light during the winter months and in dull weather, a 50 candle-power incandescent lamp being fixed on the front of the cap of each examiner. The electric light is generated by a small dynamo driven by a gas-engine.

The establishment, which is usually kept in regular operation, is equal to testing 150 tons per week of chains, cables and anchors: about 30 men are employed.

NEWCASTLE-UPON-TYNE AND GATESHEAD GAS COMPANY: REDHEUGH WORKS.

The Redheugh works are capable of producing 10,500,000 cubic feet of coal gas, and 1,500,000 cubic feet of carburetted water-gas per day.

There are four retort-houses, together with separate condensers, exhausters, scrubbers, purifiers and meters. The retorts in three of these houses are charged and drawn by means of machinery driven by compressed air. The coal is delivered into the breakers direct from the railway-wagons, and then elevated into hoppers, which feed the charging machines. In one retort-house, the hot coke is taken away, as it falls from the retorts, by means of a chain-conveyor, quenched as it leaves the retort-house, after which it is passed through a screen to remove the breeze, and is then delivered into a series of hoppers, from which it can be loaded either into wagons or carts.

Purification is carried out by means of lime.

The sulphate-of-ammonia works are capable of producing 70 tons of salt per week, from the ammoniacal liquor got at the scrubbers. The sulphur from the waste-gases is recovered by means of a Claus plant.

Carburetted water-gas is manufactured in an apparatus of the Merryfield-Westcott-Pearson type of setting. This gas is used for the purpose of enriching the coal-gas, and the plant is also useful for dealing with any unexpected or sudden demand for gas.

There are two large exhausters, each capable of passing 300,000 cubic feet of gas per hour, for pumping gas to the company's gas-holder at St. Anthony's, a distance of 3 miles. These exhausters are driven by two gas-engines of 51 brake-horsepower.

NORTHERN WOOD HASKINIZING COMPANY, LIMITED: LOW WALKER.

The extensive plant, at work haskinizing wood, comprizes two large air-compressors, two circulating engines, two steam-heaters and super-heating furnaces, cooling apparatus, two high-pressure boilers, two low-pressure boilers, and four steel cylinders or treating chambers, for haskinizing timber in lengths up to 120 feet.

THE ROLLED WELDLESS CHAIN COMPANY, LIMITED: LEMINGTON-UPON-TYNE.

These works have been started for the manufacture of chains without welds, of mild steel instead of wrought-iron. The welds, in the chains hitherto used, are not every one strong and reliable, and mild steel, as used at these works, is about 50 per cent. stronger than wrought-iron, when this has been heated to a welding heat. Welded-steel joints would be still less reliable than iron ones. The chains produced at these works (the only works of the kind so far) are thus at one and the same time the strongest and the safest made.

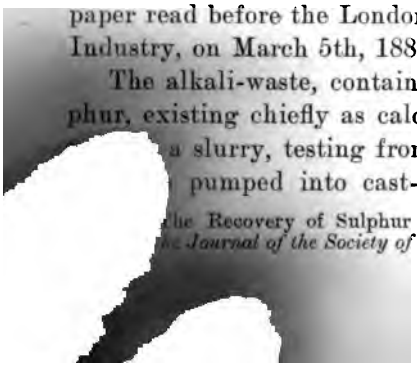
So far, in Great Britain, the railways have shewn the quickest appreciation of the system for railway-wagon coupling-chains, and six of the principal railways are already using them. The Admiralty and the London Trinity House have made full trials for their purposes, also some of the principal collieries with tub-couplings and hauling-chains, and it can only be a question of time and improved general trade to get these chains into regular use.

The visitors saw the rolling of the chain-bars and also their finishing into 1½ inches railway-wagon couplings. In very good iron, well-welded, they give a breaking-strain of about 60 tons, whereas the mild steel ones made at these works give 90 to 105 tons—and as there are no welds, there are, consequently, no weak welds.

THE UNITED ALKALI COMPANY, LIMITED: ALLHUSEN WORKS.

The Recovery of Sulphur from Alkali-waste by the Chance Process.—This plant was started in July, 1890, and a full report of this process was given by Mr. Alexander M. Chance in a paper read before the London section of the Society of Chemical Industry, on March 5th, 1888.*

The alkali-waste, containing from 10 to 12 per cent. of sulphur, existing chiefly as calcium sulphide, is mixed with water a slurry, testing from 40 to 50 degrees Twaddell. This pumped into cast-iron vessels (carbonators) through



* The Recovery of Sulphur from Alkali-waste by Means of Lime-kiln *The Journal of the Society of Chemical Industry*, 1888, vol. v , page 162.

which the carbonic acid gas, produced from burning limestone in specially constructed lime-kilns, is passed. The gas from these lime-kilns contains about 30 per cent. of carbonic acid, together with small quantities of oxygen and carbonic oxide, the remainder being nitrogen.

The decomposition which takes place in the carbonators may be divided into two stages as follows:—

I. CO_2 (Carbonic acid.) + 2 CaS (Calcium sulphide.) + H_2O (Water.) = $CaCO_3$ (Calcium carbonate.) + CaH_2S_2 (Calcium sulphydrate.)

II. CO_2 (Carbonic acid.) + CaH_2S_2 (Calcium sulphydrate.) + H_2O (Water.) = $CaCO_3$ (Calcium carbonate.) + 2 H_2S (Sulphuretted hydrogen.)

The sulphuretted hydrogen gas from the carbonators is passed into a gas-holder, and contains about 25 per cent. of that gas, the remainder being principally nitrogen from the lime-kiln gases.

A supply of air, regulated by meter, and just sufficient to burn the hydrogen of the sulphuretted hydrogen gas, is mixed with the holder-gas before entering the Claus kiln, according to the following equation:—

$$H_2S + O = H_2O + S.$$

The temperature of the gases leaving the Claus kiln varies from about 400° to 450° Fahr., sufficient to keep the sulphur in the liquid state, and the water in the form of vapour.

The sulphur is obtained in the pots situated near the Claus kilns, and is tapped into pans, where it cools and solidifies.

In order to arrest the sulphur, which is carried forward with the exit-gases in the form of vapour, large chambers, with division-walls to present as large a surface as possible for the sulphur to deposit on, are provided.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING.

HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE, OCTOBER 8TH, 1904.

MR. T. W. BENSON, PRESIDENT, IN THE CHAIR.

DEATH OF DR. HENRY PALIN GURNEY.

The PRESIDENT (Mr. T. W. Benson) said it was his misfortune to have to allude to the loss sustained by the Institute in the lamented death of Principal Gurney, of the Durham College of Science, Newcastle-upon-Tyne, one of the Honorary Members of the Institute. During the comparatively short time that Dr. Gurney had been in the North of England he had endeared himself to all who were associated with him in educational and other work. He moved that a letter of condolence be addressed to the family of the deceased gentleman, expressing the great regret of the members at his death, and conveying their sympathy with them in their bereavement.

Mr. J. H. MERIVALE, in seconding the proposal, said that although Dr. Gurney had not been very many years in the district, he had been here long enough to have left his mark behind more particularly in all matters connected with education. He was not only the head of the most important educational establishment in the district, but he had taken a very prominent part in the deliberations of the Education Committees of the city of Newcastle-upon-Tyne and the county of Northumberland. As a member of this Institute he had read some interesting papers and taken part in the discussions, and the members all deeply deplored his loss.

The vote of condolence was adopted.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings held on September 24th and that day.

G. C. GREENWELL MEDALS.

The PRESIDENT (Mr. T. W. Benson) presented the G. C. Greenwell medals to Mr. W. Blakemore, for his paper on "The Fernie Explosion";* to Dr. J. S. Haldane, for his paper on "Miners' Anæmia, or Ankylostomiasis";† and to Mr. F. W. Hardwick, for his paper on "Underground Fires."‡

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

Mr. CARL ANDERSEN, Mining and Metallurgical Engineer, Sandy, Lincoln County, Nevada, United States of America.

Mr. THOMAS AXTELL, Civil Engineer, 5, Sea View, Ryhope, *via* Sunderland.

Mr. HENRY HERBERT FISHER, Directing Engineer, Calle Once de Setiembre 1912, Belgrano, near Buenos Aires, Argentine Republic.

Mr. JAMES HENRY JEFFREYS, Mining Engineer, 32, Great St. Helens, London, E.C.

Mr. PAUL J. MALLMANN, Civil and Consulting Engineer, 116, Victoria Street, Westminster, London, S.W.

Mr. JOHN WILLIAMS, Mine and Quarry Inspector, Queen's Terrace, Llanrwst, North Wales.

ASSOCIATE MEMBERS—

Mr. FRANK B. BEAUCHAMP, Woodborough House, near Bath.

Mr. DAVID MACDONALD CHAMBERS, 23, St. Mary's Mansions, Paddington, London, W.

ASSOCIATES—

Mr. JACOB BAMBOROUGH, Deputy, Mason View, Seaton Burn, Dudley, R.S.O., Northumberland.

Mr. EDWARD COWELL, Under-manager, Boldon Colliery, Brockley Whins, R.S.O., County Durham.

Mr. WILLIAM TURNBULL, Assistant Engineer, West Holywell, Backworth Colliery, Northumberland.

Mr. THOMAS CUTHBERT WHITFIELD, Colliery Surveyor, Hylton Colliery, Castletown, near Sunderland.

Dr. THOMAS OLIVER read the following paper on "The Miners' Worm-disease as seen in Westphalian and Hungarian Collieries":—

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 450.

† *Ibid.*, 1903, vol. xxv., page 643. ‡ *Ibid.*, page 724.

THE MINERS' WORM-DISEASE AS SEEN IN WESTPHALIAN AND HUNGARIAN COLLIERIES.

By THOMAS OLIVER, M.A., M.D., LL.D., F.R.C.P.,
Physician to the Royal Infirmary, Newcastle-upon-Tyne.

At the end of last June, in conjunction with Mr. Belger, Lecturer on Literature at the Durham College of Science, Newcastle-upon-Tyne, the writer visited the coal-fields of Westphalia and Hungary with the object of studying the subject of the miners' worm-disease or ankylostomiasis. As this is the first occasion since then on which the writer has addressed an audience, he would like to seize the opportunity not only of gratefully expressing his thanks to Mr. Belger for his invaluable assistance from a linguistic point of view and his companionship, but for the enthusiastic interest which he took in the enquiry and the zeal with which he has followed it up since his return home. Before definitely fixing the date of their visit he had communicated with Dr. Tenholt, of Bochum—the head of the Medical Department of the Miners' Union of Westphalia and with Dr. Goldman, who is in medical charge of the Sopronia-Brennberg mines in Hungary, with the result that on their arrival in Germany and Austria-Hungary not only did these gentlemen place themselves at their disposal, but they did all in their power to show the writer everything that they possibly could, so as to make the enquiry comprehensive and exhaustive.

Bochum, a fairly large town with a population of 70,000, is the centre of the Westphalian coal-mining industry. Here is the Miners' Union or Knappschaftsverein, whose membership reaches 265,000. In its membership are included mine-owners, officials and working miners. The room in which the principal meetings are held is a well-lit, spacious room, rather larger than the Wood Memorial Hall, and with the seats arranged in a circular manner as is so frequently seen on the Continent. The Knappschaftsverein or Miners' Union has a capital of £2,500,000—

This fund is used for insurance purposes. Working miners contribute one-quarter and employers three-quarters to the fund. The committee, composed of 50 working men and 50 owners, is chosen by the members. The president is always an employer: he receives no salary. The president, without executive power, only directs the meetings and has the right at any time to inspect the administration. Before a miner can become a member of the Union he must have worked three years. The real executive power of the Union lies in the hands of three directors, who are paid £450 a year and are provided with a house. One of these directors must be a lawyer, another a miner and the third a merchant. There are 260 clerks employed at Bochum alone, and this does not include those employed at the several branches scattered throughout Westphalia. A Mining School, connected with the Union, is attended by 600 students. There are several large mines in the outskirts of the town, one of which (the Constantine) alone employs 4,000 men.

In Bochum is the Elizabeth Hospital, a well-appointed infirmary containing 400 beds. This was visited by the writer, who was received by Dr. Nagel, Dr. Tenholt's principal assistant. That gentleman conducted Mr. Belger and himself to the bacteriological laboratory where all the biological investigations are made. Here 300 doctors have been specially trained by Dr. Tenholt and his assistants in the methods of diagnosis and treatment of the miners' worm-disease. These men are now holding appointments throughout Germany, and are paid partly by the Miners' Union and partly by the employers. At the writer's visit to the Elizabeth Hospital, he found 19 men who were suffering from ankylostomiasis. They occupied a portion of a wing of the hospital shut off from the main building, and were provided with special lavatories. During last year, 3,000 patients were treated in this hospital for ankylostomiasis.

Coal-mining in Westphalia began about the year 1760, but it was not until 1840 that an impetus was given to the industry which has made Westphalia so prosperous. In one year alone, and that within recent times, so great was the demand for coal that 20,000 miners were introduced into Westphalia. These men came from Posen in East Prussia, from Poland, and from Italy. At present Italian miners are accepted, if they satis-

torily pass the doctor's examination of their fæces, but und
circumstances is a miner from Hungary received. The mine
ork 8 hours a day, and the average daily production per man
ton of coal. The coal is soft and is readily got by the pic
although machines are used in some of the mines for stone-wor
A hewer can earn 5s. a day, but under certain circumstances
can double or treble this amount.

Ankylostomiasis.—It is not exactly known how the mine
worm-disease found its way into Westphalia. Ankylostomia
first broke out in the Count Schwerin mine. There is an opin
that it was introduced by men who had been working in
brick-fields around Cologne, and who had gone thither from
Belgium. Dr. Tenholt believes that it was brought by miners
from Hungary. While there is considerable doubt as to
origin of the disease, there is none as to its spread by the
of water-sprays in the mines. A few years ago, in consequen
of explosions that occurred in the pits through coal-dust,
Government made water-spraying compulsory. Since then,
number of cases of ankylostomiasis has increased in a remar
able manner. In the valley of the Ruhr, the number of cas
in a few recent years, had been as follows:—1896, 107; 189
113; 1898, 99; 1899, 94; 1900, 275; 1901, 1,030; and 190
1,355.

Within the last two years, ankylostomiasis has cost th
Miners' Union and owners in Westphalia £100,000 (2,000,0
marks). At present, no man can be employed at any mine unt
he has presented a medical certificate. For every case of ank
lostomiasis notified to the Union, the doctor receives 1s. (1 mar
During the height of the epidemic, some medical men ma
large incomes from this source alone. Before a medical ma
certifies that a miner is free from the disease he must ha
examined microscopically the fæces of the applicant. For th
examination the miner has himself to pay 1s. (1 mark) to th
doctor. This was found necessary, as the miners kept flittin
about from place to place.

Lothringen Colliery.—In company with Dr. Tenholt, t
writer and Mr. Belger visited the Lothringen colliery, 2 to 3 mi
out of Bochum. There are 2,000 men employed at the pit, 1,
of whom work underground. As already mentioned, Dr.

holt, chief medical adviser to the Miners' Union, is responsible for all the medical arrangements, and has the right to inspect all the mines and miners. He has eight medical assistants working immediately under him. Ankylostomiasis broke out in the Lothringen colliery in 1885, but it was not until 1894 that Dr. Tenholt received his appointment. The post was in fact created for him. Since then at this pit, 4,000 patients have passed through his hands. Two years ago, 72 per cent. of the men were suffering from the miners' worm-disease. At the time of the writer's visit, only 8 per cent. were ill. If 6 per cent. of the men employed in any pit are found to be suffering from ankylostomiasis that mine is regarded as infected. Formerly, the men objected to be treated for the worm-disease, because they received only a minimum salary when off ill (a salary insufficient to maintain their families); now, owing to the combined action of the Miners' Union and the employers, the men when ill from this cause receive their full wages and hospital treatment free. The owners were obliged to give way to the demands of the miners, in order to prevent a riot and a strike. Two or three years ago, suspected miners would send the fæces of their wives and children instead of their own to the doctor to be examined, so great was their objection to be kept off work and to be put upon a minimum wage; but, since then, owing to full wages being paid to infected miners, the good feeding in the hospitals and the rest from work, men would come to the doctor bringing with them a jar containing the fæces of a comrade whom they knew to be infected in order that they might be allowed to go into hospital. At the present time, every miner who is suspected or who looks anæmic is obliged to pass his fæces in a special lavatory into a covered jar provided for the purpose, and under the vigilance of a mine-official.

Immediately within the entrance into the courtyard of the Lothringen colliery is the ambulance-room with annexes. This room is used for carrying out the operations just described. In another part of the buildings are suites of baths for the officials and the men.

The writer descended to a level in this colliery at a depth of 1,000 feet below the surface. Here and there along the sides of the main way were placed iron boxes, each covered with a lid. In these boxes were iron pails provided by the owners for the

cylinders standing on the first floor of the mixing houses. These cylinders reduce the constituents of the various compositions into an impalpably fine liquid. From the cylinders, the composition is allowed to empty itself into the mixing tanks, of which there are about one hundred, each capable of containing 2 tons. On the same floor, a line of rails leads to the jetty, from which goods can be loaded into barges by two overhead cranes, or lifted straight up to the higher level and put into railway trucks.

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The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings held on September 24th and that day.

G. C. GREENWELL MEDALS.

The PRESIDENT (Mr. T. W. Benson) presented the G. C. Greenwell medals to Mr. W. Blakemore, for his paper on "The Fernie Explosion";* to Dr. J. S. Haldane, for his paper on "Miners' Anæmia, or Ankylostomiasis";† and to Mr. F. W. Hardwick, for his paper on "Underground Fires."‡

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

Mr. CARL ANDERSEN, Mining and Metallurgical Engineer, Sandy, Lincoln County, Nevada, United States of America.

Mr. THOMAS AXTELL, Civil Engineer, 5, Sea View, Ryhope, *via* Sunderland.

Mr. HENRY HERBERT FISHER, Directing Engineer, Calle Once de Setiembre 1912, Belgrano, near Buenos Aires, Argentine Republic.

Mr. JAMES HENRY JEFFREYS, Mining Engineer, 32, Great St. Helens, London, E.C.

Mr. PAUL J. MALLMANN, Civil and Consulting Engineer, 116, Victoria Street, Westminster, London, S.W.

Mr. JOHN WILLIAMS, Mine and Quarry Inspector, Queen's Terrace, Llanrwst, North Wales.

ASSOCIATE MEMBERS—

Mr. FRANK B. BEAUCHAMP, Woodborough House, near Bath.

Mr. DAVID MACDONALD CHAMBERS, 23, St. Mary's Mansions, Paddington, London, W.

ASSOCIATES—

Mr. JACOB BAMBOROUGH, Deputy, Mason View, Seaton Burn, Dudley, R.S.O., Northumberland.

Mr. EDWARD COWELL, Under-manager, Boldon Colliery, Brockley Whins, R.S.O., County Durham.

Mr. WILLIAM TURNBULL, Assistant Engineer, West Holywell, Backworth Colliery, Northumberland.

Mr. THOMAS CUTHBERT WHITFIELD, Colliery Surveyor, Hylton Colliery, Castletown, near Sunderland.

Dr. THOMAS OLIVER read the following paper on "The Miners' Worm-disease as seen in Westphalian and Hungarian Collieries":—

* *Trans. Inst. M.E.*, 1902. vol. xxiv., page 450.

† *Ibid.*, 1903, vol. xxv., page 643. ‡ *Ibid.*, page 724.

THE MINERS' WORM-DISEASE AS SEEN IN WESTPHALIAN AND HUNGARIAN COLLIERIES.

By THOMAS OLIVER, M.A., M.D., LL.D., F.R.C.P.,
Physician to the Royal Infirmary, Newcastle-upon-Tyne.

At the end of last June, in conjunction with Mr. Belger, Lecturer on Literature at the Durham College of Science, Newcastle-upon-Tyne, the writer visited the coal-fields of Westphalia and Hungary with the object of studying the subject of the miners' worm-disease or ankylostomiasis. As this is the first occasion since then on which the writer has addressed an audience, he would like to seize the opportunity not only of gratefully expressing his thanks to Mr. Belger for his invaluable assistance from a linguistic point of view and his companionship, but for the enthusiastic interest which he took in the enquiry and the zeal with which he has followed it up since his return home. Before definitely fixing the date of their visit he had communicated with Dr. Tenholt, of Bochum—the head of the Medical Department of the Miners' Union of Westphalia and with Dr. Goldman, who is in medical charge of the Sopron-Brennberg mines in Hungary, with the result that on their arrival in Germany and Austria-Hungary not only did these gentlemen place themselves at their disposal, but they did all in their power to show the writer everything that they possibly could, so as to make the enquiry comprehensive and exhaustive.

Bochum, a fairly large town with a population of 70,000, is the centre of the Westphalian coal-mining industry. Here is the Miners' Union or Knappschaftsverein, whose membership reaches 265,000. In its membership are included mine-owners, officials and working miners. The room in which the principal meetings are held is a well-lit, spacious room, rather larger than the Wood Memorial Hall, and with the seats arranged in a circular manner as is so frequently seen on the Continent. The Knappschaftsverein or Miners' Union has a capital of £2,500,000.

This fund is used for insurance purposes. Working miners contribute one-quarter and employers three-quarters to the fund. The committee, composed of 50 working men and 50 owners, is chosen by the members. The president is always an employer: he receives no salary. The president, without executive power, only directs the meetings and has the right at any time to inspect the administration. Before a miner can become a member of the Union he must have worked three years. The real executive power of the Union lies in the hands of three directors, who are paid £450 a year and are provided with a house. One of these directors must be a lawyer, another a miner and the third a merchant. There are 260 clerks employed at Bochum alone, and this does not include those employed at the several branches scattered throughout Westphalia. A Mining School, connected with the Union, is attended by 600 students. There are several large mines in the outskirts of the town, one of which (the Constantine) alone employs 4,000 men.

In Bochum is the Elizabeth Hospital, a well-appointed infirmary containing 400 beds. This was visited by the writer, who was received by Dr. Nagel, Dr. Tenholt's principal assistant. That gentleman conducted Mr. Belger and himself to the bacteriological laboratory where all the biological investigations are made. Here 300 doctors have been specially trained by Dr. Tenholt and his assistants in the methods of diagnosis and treatment of the miners' worm-disease. These men are now holding appointments throughout Germany, and are paid partly by the Miners' Union and partly by the employers. At the writer's visit to the Elizabeth Hospital, he found 19 men who were suffering from ankylostomiasis. They occupied a portion of a wing of the hospital shut off from the main building, and were provided with special lavatories. During last year, 3,000 patients were treated in this hospital for ankylostomiasis.

Coal-mining in Westphalia began about the year 1760, but it was not until 1840 that an impetus was given to the industry which has made Westphalia so prosperous. In one year alone, and that within recent times, so great was the demand for coal that 20,000 miners were introduced into Westphalia. These men came from Posen in East Prussia, from Poland, and from Italy. At present Italian miners are accepted, if they satis-

torily pass the doctor's examination of their fæces, but under
circumstances is a miner from Hungary received. The miners
ork 8 hours a day, and the average daily production per man is
ton of coal. The coal is soft and is readily got by the pick,
although machines are used in some of the mines for stone-work.
A hewer can earn 5s. a day, but under certain circumstances the
can double or treble this amount.

Ankylostomiasis.—It is not exactly known how the miners'
worm-disease found its way into Westphalia. Ankylostomiasis
first broke out in the Count Schwerin mine. There is an opinion
that it was introduced by men who had been working in the
brick-fields around Cologne, and who had gone thither from
Belgium. Dr. Tenholt believes that it was brought by miners
from Hungary. While there is considerable doubt as to the
origin of the disease, there is none as to its spread by the use
of water-sprays in the mines. A few years ago, in consequence
of explosions that occurred in the pits through coal-dust, the
Government made water-spraying compulsory. Since then, the
number of cases of ankylostomiasis has increased in a remark-
able manner. In the valley of the Ruhr, the number of cases,
in a few recent years, had been as follows:—1896, 107; 1897,
113; 1898, 99; 1899, 94; 1900, 275; 1901, 1,030; and 1902,
1,355.

Within the last two years, ankylostomiasis has cost the
Miners' Union and owners in Westphalia £100,000 (2,000,000
marks). At present, no man can be employed at any mine until
he has presented a medical certificate. For every case of ank-
lostomiasis notified to the Union, the doctor receives 1s. (1 mark).
During the height of the epidemic, some medical men made
large incomes from this source alone. Before a medical man
certifies that a miner is free from the disease he must have
examined microscopically the fæces of the applicant. For this
examination the miner has himself to pay 1s. (1 mark) to the
doctor. This was found necessary, as the miners kept flitting
about from place to place.

Lothringen Colliery.—In company with Dr. Tenholt, the
writer and Mr. Belger visited the Lothringen colliery, 2 to 3 miles
[illegible] There are 2,000 men employed at the pit, 1,6[illegible]
[illegible] As already mentioned, Dr. T[illegible]

holt, chief medical adviser to the Miners' Union, is responsible for all the medical arrangements, and has the right to inspect all the mines and miners. He has eight medical assistants working immediately under him. Ankylostomiasis broke out in the Lothringen colliery in 1885, but it was not until 1894 that Dr. Tenholt received his appointment. The post was in fact created for him. Since then at this pit, 4,000 patients have passed through his hands. Two years ago, 72 per cent. of the men were suffering from the miners' worm-disease. At the time of the writer's visit, only 8 per cent. were ill. If 6 per cent. of the men employed in any pit are found to be suffering from ankylostomiasis that mine is regarded as infected. Formerly, the men objected to be treated for the worm-disease, because they received only a minimum salary when off ill (a salary insufficient to maintain their families);. now, owing to the combined action of the Miners' Union and the employers, the men when ill from this cause receive their full wages and hospital treatment free. The owners were obliged to give way to the demands of the miners, in order to prevent a riot and a strike. Two or three years ago, suspected miners would send the fæces of their wives and children instead of their own to the doctor to be examined, so great was their objection to be kept off work and to be put upon a minimum wage; but, since then, owing to full wages being paid to infected miners, the good feeding in the hospitals and the rest from work, men would come to the doctor bringing with them a jar containing the fæces of a comrade whom they knew to be infected in order that they might be allowed to go into hospital. At the present time, every miner who is suspected or who looks anæmic is obliged to pass his fæces in a special lavatory into a covered jar provided for the purpose, and under the vigilance of a mine-official.

Immediately within the entrance into the courtyard of the Lothringen colliery is the ambulance-room with annexes. This room is used for carrying out the operations just described. In another part of the buildings are suites of baths for the officials and the men.

The writer descended to a level in this colliery at a depth of 1,000 feet below the surface. Here and there along the sides of the main way were placed iron boxes, each covered with a lid. In these boxes were iron pails provided by the owners for the

n to defæcate into. Some of these boxes were screened
m view by sacking and the soil round about them was soak
th lime so as to disinfect the men's boots that might acciden
dly become infected. The colliery regulations are extreme
tringent in regard to the irregular disposal of dejecta by t
men. Not only are fines imposed, but the workmen themselv
have taken up the matter in self-defence, and are not slow
see that the rules are enforced and penalties exacted when th
are broken. The pails are removed on trucks daily, taken
the surface, emptied and disinfected. Here and there, along t
sides of the track over which the writer travelled, were po
of stagnant water and accumulations of sludge, which co
tained myriads of the larvæ of the *Ankylostoma*. The larvæ
the worm attack the wooden props in the pit, but they seldo
rise higher than 3 feet. Beyond this height are found filifo
or worm-like bodies known as rhabdites. They are not unlike t
larvæ of *Ankylostoma*, and they often make their way to t
cross-beams. These rhabdites, along with the larvæ of the t
worm, cause the wooden props to become moist and soon
become rotten.

We made a point of inspecting one of the galleries that w
known to be badly infected. This roadway was not in use
the time. Dr. Tenholt had voluntarily allowed this passage
become infected by miners who were known to be suffering fro
the malady, with the view of determining the length of ti
required to infect a particular part of a mine and the numb
of days necessary to transform the ova passed in the dejecta
infected miners into active larvæ. All the conditions here we
favourable for this. The roadway was narrow, the temperature w
fairly high, and the soil was wet. Dr. Tenholt ascertained that
14 days the ova passed in the stools of infected miners had mo
of them developed into larvæ. It is interesting to note that,
long as carbonic acid gas was present in the air of this particul
roadway in moderate quantity, the larvæ hardly develope
at all; but when more air was passed in and the ventilatio
improved the larvæ quickly appeared. This circumstance show
that external to the human body, just as internal to it, oxyg
is necessary for the transformation of ova into larvæ. Havi
ascertained the length of time necessary to transform ova i
larvæ in the mine, Dr. Tenholt was carrying out a series

experiments of a preventive character: these consisted in spraying the walls of the passage and the wooden props, for fully 3 feet above the floor, with a solution of quicklime. The results were said to be satisfactory.

Erin Colliery, Gastrop.—From the Lothringen colliery, the writer drove 3 or 4 miles farther to the Erin colliery, where 1,500 men are employed. The writer inspected the dressing-room or vestiary of the men who work underground, with its 1,500 cords, running up to the ceiling, used for suspending the clothes and the boots of the miners. Here the men change their clothing before and after work. This room has a cement-floor and perforated seats, and is kept warm by steam. Adjoining it is a bath-room with a cement-floor, white brick-walls and a long tray, 6 inches wide, running down the centre, used for holding soap. Towels and soap must be brought by the miners themselves. Leading out of the vestiary is another long room, divided off into two rows of stalls, used as water-closets. The floor is red-tiled, the stalls are composed of an iron frame-work retaining slabs of black marble; the seats of the water-closets are well finished, and are made of a hard red wood, and when they rise, after having been used, there is automatically a flush of water. For the men who are working on the surface there is set aside a place with stall-like water-closets, similar to those just mentioned.

Nothing can exceed the cleanliness and the excellence of the vestiary, bath-room and closet-accommodation provided for the men at the Erin colliery. To some extent no doubt it is a show-place, but the men and lads whom we saw dressing therein were clean and seemed to have enjoyed their bath thoroughly. One of the results of the use of the washing accommodation provided for the men at the pit-head is that in this part of Westphalia you never meet, as in England and Scotland, a begrimed collier on the road. The writer saw several miners, but it was impossible to tell whether the men were going to or coming from their work.

Hospital at the Erin Colliery.—The hospital is a wooden framework filled in with thick cardboard. On the day of the writer's visit it was occupied by 25 patients. The two wards

can, at a pinch, accommodate 50 men. Attached to the hospita are a kitchen, mess-room and dry-closet accommodation. Th men did not look ill, nor were they very anæmic. Dr. Perne the doctor in charge, said that he had tried to ascertain ho long the larvæ of the *Ankylostoma* could live in the mine if un disturbed. In March, 1903, the iron-pail system was introduce into the Erin colliery, and it is presumed that after that no fres infection occurred. As some lads who entered the pit for th first time in the following November caught the disease, th circumstance suggests that the larvæ of the *Ankylostoma duodena* can live as long as 8 months at least, and probably longer, in t mine if undisturbed. Dr. Perner receives a salary of £25 a mon from the owners of the Erin colliery, but he is appointed by t Miners' Union, of which body he is a permanent official and c therefore be sent to any mine. Each patient at the Erin hospi costs the employers 4s. 6d. per week.

Sopron-Brennberg Colliery, Hungary.—After leavi Bochum, the writer and Mr. Belger proceeded to Vienna a thence to Sopron-Brennberg, Hungary, where they were recei by Dr. Goldman, medical officer to the mine. Seven years a when Dr. Goldman received his appointment, upwards of per cent. of the miners were affected by the worm: at the prese time about 30 per cent. of the men are suffering from ank lostomiasis. A few years ago, when the mine was more infecte than now the men suffered considerably in their health. The were extremely anæmic, and so ill that they could not follo their employment. Their feet were swollen, and the men on th slightest exertion became so short of breath that many of the could scarcely walk. By degrees the virulence of the epidemi has subsided, so that new patients do not suffer so severely as th miners of a few years ago.

The temperature of the Sopron colliery is in places high, 104 to 108° Fahr. (40° to 45° Cent.), but if the heat is not lowere by sprays of water, Mr. Rudolph, the engineer to the colliery says that it may rise to 173° Fahr. (80° Cent.).* He showed th writer red, angry-looking sores on the back of his hands, whic had been caused by water dropping on to them from hot coal

* Throughout the mines, there are cisterns, filled with water and compress air at a pressure of 30 atmospheres; and these are turned on, now and then, cool the mine.

the pit. The sores had all the appearances of being burns. The mine is a little more than 1,100 feet (337 metres) deep. Ventilation is somewhat difficult. It is a pitch-coal that is got, and it sells for about £2 a ton. The mine requires very careful propping, on account of the brittleness of the stone, the fact that the strata are irregularly bedded and that there is enormous pressure. Fires frequently break out in the pit. Owing to the cracking of the coal that is constantly taking place, a very fine dust is liberated which is extremely hot to the hand; and it is this dust which is said to catch fire. Gases are present in the mine, but not to any serious extent. Naked lights are employed. Although the temperature in the Sopron colliery is high, there is yet at places in the pit a considerable amount of moisture and sludge around the wooden props. Many of the props are wet, and it is stated that the larvæ of the *Ankylostoma* rise to a higher level on the props at Sopron than they do in Westphalia. Dr. Goldman told the writer that he had found the larvæ on the cross-beams.

During the winter, 1,000 men are employed in the Sopron colliery, but in the summer, owing to a diminished demand for coal, about 200 of the men get employment in the fields.

Sick Fund.—There is no Miners' Union in Hungary, and as a consequence there are no strikes. There is no combination of employers nor of workmen. Each mine exists by and for itself alone. At the Sopron colliery there is a sick fund, the Brüderlade, with a capital of £25,000, which is used for paying pensions and for all kinds of sickness. To this fund the married men contribute a little less than 1d. for every 10d. of their wages and the unmarried men about a ½d., while the owners contribute annually £1,000 to the fund and £40 to the school. The administration of the fund costs £34 a year. The Brüderlade gives 10d. to each family per day during sickness and 8d. to unmarried men and it pays all hospital expenses. In addition to the 10d. per day paid by the fund the owners give to sick miners who have worked for some years, 8s. 4d. a month, but this is a purely private benefaction the control of which they retain in their own hands.

Wages of Miners and the Condition of the Mine.—On an average, the men are paid 2s. a day, but when working by the

ece they can sometimes make as much as 5s. The hewers wo[illegible]
hours and the timber-men 10, but out of these 8 hours, owi[illegible]
o the high temperature of the mine and the exhausting charact[illegible]
of the work, the men spend half of the time in cooling the[illegible]
selves. Two men are always associated—one works while t[illegible]
other cools and rests himself. In consequence of the hig[illegible]
temperature of the mine and the profuse perspiration which
causes, the miners are all thin spare men and sallow-lookin[illegible]
They suffer from intense thirst and as they will not drink a[illegible]
of the water in the mine the owners have to provide water co[illegible]
taining 1 per cent. of citric acid, at considerable expense. T[illegible]
drinking water thus provided costs the employers £120 a ye[illegible]
Often the men drink as much as 8 to 9 pints a day. The drin[illegible]
ing water is carried into the mine by boys in barrels fixed
their back. These boys always travel in couples owing to t[illegible]
frequent fires that keep breaking out. Notwithstanding
very high temperature of the mine and the consequent exhau[illegible]
ing nature of the work, each man produces about 1 ton of co[illegible]
per day, but the coal is on the whole easily got.

Boys may commence work on the surface at the age of 14[illegible]
at 16 they may become water-carriers in the mine or putter[illegible]
at the age of 20 they are apprenticed as hewers, and 3 yea[illegible]
afterwards they are full hewers. At the age of 14 a boy ca[illegible]
earn 8d. a day: between 16 and 20 he can make 10d. to 3s
if he is physically well developed. Girls can earn 9d. a da
by sifting coal at the surface.

There are no baths at the Sopron colliery for the workmen
owing partly to the difficulty of getting water. The men wa
at home, as in England.

Ankylostomiasis.—The Sopron colliery has been working
the past 150 years. It is not definitely known how
worm found its way into the pit. There is an opinion
it was brought by Italian workmen on leaving the St. G[illegible]
tunnel in 1890-1892, but Mr. Rudolph, the manager
mine, stated that as far back as 1864 the miners' worm-
existed in Hungary. In medicine and hospital treatme[illegible]
ankylostomiasis cost the owners of this pit £150 last y[illegible]
cases of worm-disease being treated by Dr. Goldma[illegible]
employers have some difficulty in getting the men t[illegible]

receptacles provided for their use in the mine.* The fæces are sprinkled with dry coal-dust, which acts as an antiseptic, and the receptacles are removed to the surface and emptied daily.

Hospital at Sopron-Brennberg.—The hospital is in the village and not at the pit-head, as in the case of the Lothringen and Erin collieries in Westphalia. On the occasion of the writer's visit 12 beds were fitted up for patients, but only 2 of these were occupied by men suffering from ankylostomiasis. There is accommodation in the hospital for 24 patients. Many of the miners who are suffering from the worm prefer to be treated as out-patients. The writer examined 6 infected miners—from the fæces of one of them he saw 70 fully-grown worms removed by Dr. Goldman.

Ankylostoma duodenale, or the Miners' Worm: its Habits, How it gains Entrance into the Human Alimentary Canal and the Symptoms which it Causes.—When the disease affects for the first time a mine, the men who become infected generally suffer rather severely. As time goes on, either the men become more resistant to the ravages of the parasite, or the worm itself becomes less virulent, for occasionally at a *post-mortem* examination there may be many ankylostomes found in the intestine without any grave symptoms having been detected during life. Since the discovery of the worm by Dubini in 1838 and the publicity given to it by Perroncito in connection with the making of the St. Gothard tunnel the parasite has been found in all tropical and sub-tropical countries. It is abundantly present in the south of Europe, in India, Ceylon, Egypt, certain parts of South America and Australia, and Dr. J. S. Haldane has found it in the Dolcoath mine in Cornwall. In Egypt, it is extremely prevalent, and frequently gives rise to such a profound form of anæmia that it is one of the commonest causes of the rejection of recruits in the Army. In Ceylon, one medical authority regarded its ravages as more serious than those of cholera, not so much on account of the number of deaths that it causes as the amount of ill-health which it directly and indirectly induces, and the unfitness for work that it brings about. The writer has

* There is no law in Hungary, as in Germany, empowering employers to enforce regulations regarding the use of these receptacles for the dejecta of workmen in the mine.

already alluded to anæmia, swelling of the feet, shortness of breath and inability to walk any distance, as the principal symptoms of ankylostomiasis. To these may be added digestive derangements, effusions into the pleural and peritoneal cavities, fatty degeneration of the heart and fatal syncope. Fatal cases fortunately are not common, although in a few instances a high degree of bloodlessness has been rapidly attained and death has ensued within a few weeks after the symptoms first showed themselves. It is among the ill-fed, badly-nourished and poverty-stricken populations that the ravages of the disease are most marked.

The normal habitat of the parasite is the upper part of the small intestine of man. Here the worm attaches itself by its six claw-like hooks to the lining membrane of the alimentary canal, from which it draws a plentiful supply of nourishment. It was formerly held that the parasite caused anæmia by literally sucking the blood of its host, and certainly in several of the worms recently passed which the writer examined there was a considerable quantity of blood. The late Dr. Beaven Rake believed that anæmia in miners was entirely due to the abstraction of blood by the parasite. Dr. Looss, of Cairo, however, has shown that the presence of blood in the worm is more or less an accident, and that what the worm lives upon is the mucus and the material secreted by the large cells lining the intestinal mucous membrane. In a paper which the author wrote for the International Congress on Ankylostomiasis held in Cologne, six weeks ago, he discussed the probable causes of the anæmia. He rather leaned to the opinion that the worms themselves formed some poison or toxin, which is absorbed by the person harbouring the parasites and the circulation of which through the body breaks up some of the red corpuscles of the blood and destroys their colouring matter. In addition to the impoverishment of the blood, which is the explanation of the anæmia, there is often found an excess of one form of the colourless corpuscles of the blood known as eosinophiles. Eosinophilia, while undoubtedly present in ankylostomiasis, is also induced by intestinal parasites other than the *Ankylostoma*. It is also met with in other diseases, so that although eosinophilia is a physical sign of considerable importance, still it cannot be regarded as absolutely clenching the diagnosis.

The ankylostomes are male and female, and are generally ent in the alimentary canal in the proportion of one male ree females. The male measures from about ¼ to ½ inch in th by $\frac{1}{76}$ inch in breadth, while the female measures about ¾ in length and is also slightly broader than the male. The ms are "white when they are alive, grey when dead, and ish-brown when full of blood. . . The tail of the le is conical and ends in a short spine, the anus being erminal and the vagina opening on the ventral surface. . The tail of the male is provided with a large, umbrella-trilobate bursa possessing 11 ribs. Two long and very ate spicules project from the cloaca which opens at the m of the bursa."*

he female ankylostome produces an enormous number of which are constantly being passed out in the fæces. The lo not advance to any further stage in the human intestine, if the fæces are deposited where there is moisture and a warm temperature, the ova develop into larvæ which at are very active and extremely voracious. These larvæ, as writer found in the Westphalian collieries, may live in the dy water and sludge, and on the wooden props for several ths.

It has hitherto been generally believed that miners become fected by the worm, through eating food with unwashed hands drinking contaminated water, and there is not the least doubt at this is one of the channels by which the larvæ gain entrance to the alimentary canal, but it remains to the credit of Dr. oss, of Cairo, who accidentally became infected by a culture of e worm coming into contact with the skin of his hand, to ve demonstrated that in a very large number of cases the bryo gains an entrance through the skin, passes into a small in, and is carried to the right side of the heart whence it goes the lungs. Here it emerges from the thin-walled pulmonary od-vessels and escapes into the air-spaces of the lung. The va is by this time larger than when it entered the body. It w makes its way along the bronchi, up the windpipe to the arynx and thence passes down the gullet into the stomach, m which it proceeds into the small intestine. By means of

* *Tropical Diseases*, by Sir Patrick Manson, M.D.

the lantern-views which the writer has thrown upon the screen, and for the loan of which and the privilege of using them he is indebted to Dr. Looss, the members will have had no difficulty in following the larva from its entrance through the skin to the heart, lungs, stomach and intestine. The writer regards this demonstration of Dr. Looss as one of the most important contributions to scientific medicine that it is possible to have. Dr. Looss has been rewarded for his patience and determination. It is but recently that Dr. Looss' views have been accepted, and that is only since he has exhibited the slides which the writer has had the opportunity of throwing upon the screen. Recently Dr. Fritz Schaudinn, of the German Imperial Board of Health, has by his experiments upon monkeys confirmed in every detail the views put forward by Dr. Looss. In one monkey, killed 12 days after the application of the larvæ to the skin, 36 living ankylostomes were found in the intestine. Dr. Looss had shown that within 2 days, after the application of the larvæ to the skin, the parasites are present in the intestine.

The conclusion to be drawn from Dr. Looss' discovery of the channels by which the larvæ reach the human intestine is that personal cleanliness on the part of the miner, so far as eating food only after washing is concerned, is not enough. Since the larvæ enter by the skin, the mine also must be seen to. There is a general consensus of opinion that a low temperature and absence of moisture are unfavourable circumstances for the transformation of the ova into larvæ; and in Westphalia, the writer learned that by means of improved ventilation the temperature of several of the pits had been so reduced that the collieries had been thus freed of infection. The collieries that have remained free have had a temperature lower than 62 Fahr., and have been, comparatively speaking, dry: those on the other hand that became infected were damp, and had a temperature above 80° Fahr. Dr. Lambinet, of Liége, has found that in some of the collieries near Liége in which the temperature varies from 60° to 64·4°Fahr., the men employed underground have suffered from the worm-disease. Accordingly, Mr. Lagage, one of the assistants in the bacteriological laboratory of the provincial institute at Hainaut has sought to determine the lowest temperature at which segmentation of the ova occurs. Flasks

ing fæcal matter and ova were placed in chambers of
t temperatures and it was found that at 66·2° Fahr.
tation of the ova was practically *nil*, at 71·6° Fahr.
tation was not only complete, but in some instances
embryos could be seen inside the capsule of the egg while
° Fahr. free larvæ were present. Mr. Lagage's experi-
herefore demonstrate that the ova of the *Ankylostoma*
hatched at degrees of temperature ranging from 68° to 98°
the latter being, practically speaking, blood-heat. Dr.
ito has, in addition, shown that the eggs do not develop
væ if they are kept for several days at too high a tempera-
y, from 95° to 104° Fahr. If it were true that the larvæ
Ankylostoma do not appear at a temperature below 68°
hen, by means of improved ventilation and the consequent
on of temperature, owners would have one means at hand
y infection might, to some extent, be prevented. Low
tures can, certainly, retard and may prevent the trans-
on of ova into larvæ. While at a temperature of 68° Fahr.,
binet found that by the fourth day free larvæ had escaped
e ova, it was not until the sixth day at a temperature of
hr. that a few free larvæ were detected, and while
f the ova did not develop further, many of the larvæ if
this temperature died. At temperatures varying from
9° Fahr., it was not until the eighth day that a few small
rvæ were seen, and not until the fifteenth day that they
reased both in size and in number. A large percentage of
also failed to develop at all. At temperatures varying
·6° to 55° Fahr., it was only after twelve days of culture
ew larvæ appeared, while with temperatures varying from
53·6° Fahr., development hardly proceeded at all. Low
tures, that is, anything below 40° Fahr. killed the ova;
did rapid variations of temperatures from high to low.
cumstances that favour the transformation of the ova
væ are three:—(1) A temperature between 68° and 98°
(2) a certain degree of moisture; and (3) the presence of
in the air.

s owing to the comparative absence of oxygen in the
al canal that the ova do not develop therein into larvæ.
the fæces of an infected subject are examined, a few
fter being passed, the ova are already found to have

undergone segmentation and may contain 2, 4, 8 and sometimes as many as 12 segments. Any larvæ present in fæces recently passed, are as a rule not those of an early stage of the *Ankylostoma*, but are the undeveloped organisms of another intestinal parasite, namely, the *Anguillula stercoralis*. An additional circumstance, besides the absence of oxygen which prevents the development of the ova of *Ankylostoma* into larvæ in the human intestine, is the somewhat too high temperature of the intestine, which is a little over 98·5° Fahr.

Treatment of Ankylostomiasis: Preventive and Curative.—The medicinal part of the treatment may well be left to the medical men in charge. It is with preventive treatment that the members are, to-day, most concerned. The disease might be prevented (1) by making the mine healthy, but it is not always easy to render a damp mine dry and it is often difficult to reduce the temperature; (2) by prohibiting infected men from working underground; and (3) absolute prohibition of the miners defæcating underground, unless into the receptacles provided for that special purpose. Means should be taken to screen off these receptacles in the mine, and the men should be encouraged as far as possible to use the closet-accommodation provided for them at the pit-head.

Since the writer's visit to Hungary the Austrian Minister of Agriculture has issued a set of regulations, which should do much to prevent the spread of the miners' worm-disease in Hungary. New miners must pass a medical examination (three samples of dejecta being examined under the microscope) and in the case of an infected mine, 10 to 20 per cent. of the underground staff must be examined microscopically. This requires great care and special experience, as rhabdites are often with difficulty differentiated from the larvæ of *Ankylostoma*. The sludge in various parts of the workings must also be examined. Miners who have been infected and treated must produce a medical certificate of freedom from the disease, before again being allowed to work. Each working colliery must provide suitable closet-accommodation, aboveground and belowground, one cabinet for every 30 men of the staff; but at infected or suspected mines the number of cabinets must be not less than

1 to every 20 men of the total staff. The receptacles must be emptied and disinfected daily. A proper supply of drinking water in closed vessels must be provided for the men, changed once a day, and the taps so arranged as to prevent direct drinking from the spouts or contamination by dirty hands. These regulations, with others which the writer has not had time to mention, will do much to prevent the spread of ankylostomiasis in Hungary and it is hoped may ultimately lead to the disappearance of the miners' worm-disease.

The PRESIDENT moved a vote of thanks to Dr. Oliver for his valuable paper.

Mr. J. B. ATKINSON (H.M. Inspector of Mines), in seconding the proposal, said that in this district they were in the fortunate position of not being actually infected by the worm, and what they had to consider was the precautions to be taken to prevent its introduction, rather than deal with it after it had established itself. The conditions of the collieries in Northumberland and Durham were perhaps not altogether unfavourable to the introduction of the worm, because the temperature in many cases was about that mentioned in the paper (namely, above 68° Fahr.); in a few cases it was perhaps as high as 80° Fahr., but in most cases, where the temperature was high, the air was very dry, and the absence of moisture prevented the propagation of the worm. In a few metalliferous mines in the North of England, including some of the hæmatite-mines in Cumberland and Lancashire, although the depths were not very great, the conditions of moisture at the working-faces accompanying a comparatively high temperature might be more favourable for the development of the worm than the conditions found in the coal-mines. He thought that they ought to take advantage of the scare which has arisen in connection with this disease, and adopt better sanitary precautions in the mines. He (Mr. Atkinson) did not know that it would be necessary in this district to provide pails at the working-faces, but at flats and landings and at the pit-bottoms he thought that there should always be some provision made for the use of the miners. In some mines, where pails were provided, the surroundings became so filthy that no respectable miner would use them. The men were also recom-

mended to cultivate regular habits, in the way of relieving themselves on the surface, but the custom in this district of two shifts of hewers prevented these men from adopting such regular habits, as for one week they worked in the fore-shift and the next week they worked in the back-shift. Dr. Oliver had mentioned, that it had been suggested by some one in Germany that horses or ponies might have introduced the disease into the mines. The seams in the North of England being so flat, there was probably more horse-haulage here than in most other districts. With regard to foreigners conveying the disease, it was known that there was a considerable number of Poles working in collieries in Scotland, and he believed that there had been at least one suspected case of ankylostomiasis dealt with in one of the Glasgow infirmaries. There was no evidence, however, that the disease had established itself there. There was a considerable number of Italian miners in the neighbourhood of Nenthead in Cumberland, and the matter was having careful consideration in that district as to whether these Italians might introduce the disease.

Mr. T. E. FORSTER asked whether there was any difference in people as to their liability to take the disease, or as to how they were affected by it. It always seemed to him that the workers in the collieries here were a healthier class of men than those employed in metalliferous mines. In the latter mines, the men were usually anæmic. In German mines, where they had a changing house, did the men change the whole of their clothes, or only their outer garments? If the whole of the clothes were changed, was there any arrangement for washing them, for if they were allowed to remain hanging for a considerable time in a dirty state they would become a source of infection?

Mr. J. H. MERIVALE said that one great difficulty in introducing such precautions in this district as Dr. Oliver suggested was the conservative tendency of the North-country workman. Fortunately, in the northern part of the coal-field there was not much chance of the disease obtaining a foothold, on account of the lowness of the temperature. He agreed with Mr. Atkinson's suggestion regarding the provision of conveniences at the shaft-bottom, but he did not think that they could be introduced

all over the mine. At one of his collieries, conveniences had been in use at the shaft-bottom for some time, the men used them regularly, and there were not now the same objectionable conditions as existed formerly in that vicinity. He (Mr. Merivale) would like to see the system of washing and changing of clothes at the pit introduced into this country, in order to enhance the health of the miners. Although undoubtedly healthy as compared with Cornish miners, they suffered from various diseases, which he believed were induced by chills, owing to the men waiting about in their pit-clothes. He thought that it would be advantageous to provide proper washing arrangements, together with arrangements for drying the clothes. He had had some experience in the mines of Belgium and Germany, and at one colliery where he was for six months, the workmen, instead of hanging up their clothes, put them through a hole in the wall and they fell into the basement where they were washed, and clean ones sent up in their place.

Mr. J. C. B. Hendy said that it occurred to him that mining engineers in Hungary and Westphalia were starting at the wrong end, and were taking elaborate measures for destroying the worm after they had got it; but they were not taking such precautions as they should in the working of the mine, in providing a larger amount of ventilation and such area of airways as would conduce to lower the temperature of the mines, at any rate, below 60° Fahr.

Mr. W. C. Blackett wrote that by far the most important part of Dr. Oliver's extremely interesting and valuable contribution to our information on ankylostomiasis was that referring to Dr. Looss, of Cairo, and his observations on worm-infection through the skin. Dr. Looss appeared to have removed the doubt which existed, and to have placed this question on a shelf of certainty, where most decidedly it called for a change in many of the views hitherto formed as to both the precautions which should be taken against the possibility of the disease as well as against its treatment when established. Most of the mines in Durham and Northumberland were more or less safe owing to their temperature, and those, where the temperature was high enough, were fortunately dry as a rule. The very few instances, if any, where conditions were favourable to the worm might, by

special enquiry of the Institute, be discovered, and then specially reported on.

But many other dry and warm mines were placed on the horns of a dilemma by the watering which was required to lay the dust. This would, and perhaps did, produce in Durham several instances of favourable conditions. Ought watering in mines of high temperature to be continued? In the face of grave possibilities of the worm-disease this became a serious question.

He (Mr. Blackett) had been considering whether some form of oil could not be used on dusty road-ways. It had proved very efficacious in use on dusty roads at the surface; and there appeared to be merely a sentiment so far as fire-danger was concerned. Oil would prevent the development of the worm; while, if the mixture of dust and oil were from time to time removed, its value would largely be recovered by its use as fuel. He proposed to make experiments, and would perhaps have some other opportunity of laying results before the members.

For the present, it was to be hoped that the Local Government Board and other authorities would cause the disease to be reported in the same way as other infectious diseases, and so ensure some early knowledge of its possible existence.

Dr. ARTHUR E. BOYCOTT (Gordon Laboratory, Guy's Hospital, London) wrote that the account which Dr. Oliver had given of his observations on the occurrence of the worm-disease in Westphalia, and on the results of the treatment which had there been adopted, was of great interest. For he shewed very clearly that the worm, when once it had gained a foothold in a mining district, was extremely difficult, if not impossible, to eradicate completely. By measures of the most drastic and expensive character the number of men who were materially ill had been reduced practically to *nil*, and the percentage of miners who harboured the worm had been very considerably reduced. But it was important to note that the great sacrifice of labour and money which had been devoted to the epidemic had not succeeded in completely extirpating the worm from every underground worker, and so long as any single man remained infected there would always be a danger of the disease spreading. Still less had the worm been cleared out from the mines. Dr. Oliver

d described how the water and timber swarmed with *Ankylo-ma*-larvæ, which seemed to possess great powers of vitality. long as this state of affairs continued, it was clear that the tensive plant of doctors, examinations, hospitals, and the like ist be maintained, and the cost of these must remain a con-nt charge upon the financial resources of both masters and n. Any relaxation of the curative system now in vogue uld be followed by a recrudescence of the malady, which ild only be dealt with by the resumption of these expensive ceedings. That a vast improvement had been effected in stphalia could not be doubted, and those concerned were to be rtily congratulated on the success which had attended their oic efforts. Unfortunately, however, the success seemed to of a palliative kind only, and the ultimate outlook could not described as hopeful.

It seemed, then, to be practically impossible either to render ry individual completely free from the worm, or to eradicate larvæ from a mine and so render it safe for fresh hands. at was to say, the complete removal of the worm from an ected district could not, so far as our present experience went, looked upon as reasonably within the range of practical itation. This fact should emphasize especially the para-unt importance of taking measures to prevent the introduc-n of the worm into the mines in this country. The provision of a proper system of closets on the surface and of movable s underground, combined with a system of limited quarantine medical examination for fresh hands coming from infected ces—these were simple measures of common precaution. The ndest proof that a sanitary regulation was good was often nd in the apparently unnecessary character of its provisions: this way the comparatively small expense of the provision d upkeep of a proper system for the disposal of excreta under-ound would find its best vindication in the complete and rmanent absence of *Ankylostoma* from British mines. It was be feared, on the other hand, that the introduction of the isease might some day afford a highly unnecessary proof that he present underground usage was thoroughly bad.

It was sometimes suggested that the infection of the water nd mud in a mine must ultimately cease if fresh contamina-on were prevented. There was every reason to believe that this

view was theoretically correct, for the older theories that *Ankylostoma* could develop to sexual maturity and multiply outside the body, lacked confirmation. But practically it was extremely doubtful whether any reliance could be placed on this mode of cure. How long the larvæ could live in water had not been determined: Dr. Oliver had told the members that at Er- in colliery there was good evidence that the larvæ lived for at least 8 months underground, and at the present time (Octobe- 1904) he (Dr. Boycott) had larvæ still alive which were hatch- in his laboratory in November, 1903. These eleven months th- had spent in small glass dishes with no more nourishment tha- that contained in the fragment of fæcal matter which original- held the eggs and in the London tap-water which had bee- added from time to time to make up for evaporation. Many them had died, but a large proportion were still alive a- appeared to be quite vigorous and healthy. The conditions life under these artificial circumstances could hardly be favourable as those met with in their natural habitat unde- ground, so that it was not unreasonable to assume that in min- the larvæ could live for some period which was unknown, b- which was certainly more than 12 months. It was unfortu- ately almost impossible to make accurate observations on th- point under entirely natural conditions. This was due to t- fact that the mud and water, and especially the fæces, found in mines* swarmed with larvæ which, while in many instan- bearing a very close resemblance to those of *Ankylostoma*, rea- belonged to other species of worms that lived in the ear- etc., and were not parasitic at all. This could be shewn by keeping these larvæ for some little time in suitable surrou- ings, when it would be found that many of them developed to forms which were completely dissimilar to any stage in the development of *Ankylostoma*. While it was often easy to say positively at once that the larvæ found were not those of *Ankylostoma*, he had come to the conclusion, after careful examination of many specimens, that it was beyond his own powers of discrimination to identify positively any given larva found in a mine as a young *Ankylostoma*. All that could be said was that

* That is, all that he had had an opportunity of examining. These included infected and non-infected metalliferous mines in Cornwall and coal-mines in the Midland counties.

it might not appear to differ from genuine *Ankylostoma*-larvæ, but one had to allow that it might be the larva of some other worm. On this account, observations made on the occurrence of so-called *Ankylostoma*-larvæ in the water, timber, etc., in mines should be received with caution. Any statement as to the occurrence of *Ankylostoma* founded on such evidence alone was utterly untrustworthy.

There seemed to be some difference of opinion as to the lowest temperature at which development of the eggs would take place. Dr. Bruns found that a temperature of at least 68° Fahr. was necessary for the production of the full-grown (that is, infective) larvæ, though some eggs might hatch at somewhat lower temperatures. Careful observations made by Dr. J. S. Haldane, and himself (Dr. Boycott) with the accurate incubators made by Mr. Hearson, shewed that some lots of eggs failed to develop at 62° Fahr., or indeed in some instances at any temperature: in other instances, however, they found that full-grown larvæ appeared in cultures which had never been exposed to a temperature of more than 62° Fahr. They (Drs. Haldane and Boycott) concluded from these and other experiments that the temperature should be below 60° Fahr. to prevent the development of infective larvæ, and it was of great importance not to encourage any feeling of security which might have arisen from the fact that the temperature in any given mine was not higher than 68° Fahr.

Without a free supply of oxygen the eggs would not hatch at any temperature. Oxygen was sufficiently excluded by even a thin layer of water covering the infected stools, or by tightly corking a bottle containing such material. The fermentative changes going on in fæces in a warm, confined place quickly removed the oxygen from the surrounding air.

The larvæ, on the other hand, were to a large extent indifferent to temperature and oxygen. They would flourish at any temperature from 50° Fahr. up to about 90° Fahr. (the exact limits had not been worked out); they lived well in water, and for 20 days would survive in an atmosphere of hydrogen. It consequently followed that it was not possible to kill off the larvæ about a mine by any procedure such as cooling, allowing the pit to fill with fire-damp and black-damp, etc. These conditions would only affect the eggs. It also followed that if conditions

suitable for the hatching of the eggs existed in any part of a mine, the whole of the wet roads might become infected (whatever the temperature might be) by the transference of the developed larvæ from the warmer parts on boots, tubs, etc., or by a natural flow of water. So, too, it was necessary to ascertain not the average temperature of a mine, but the temperature of the hottest part which work-people frequented.

In conclusion, he (Dr. Boycott) would like to point out the desirability of more extensive and accurate information as to the actual temperature of the underground workings in coal- and metalliferous-mines in this country. A collection of figures from a number of districts would afford a sound basis for considering how much truth there was in the suggestion that a large number of mines in this country were too cold for *Ankylostoma.*

Dr. J. Court (Staveley, Chesterfield) wrote that Dr. Oliver's lucid and able account of the disease and the methods of dealing with it in Westphalia was most instructive. In the event of an outbreak of ankylostomiasis in Great Britain, he was afraid that our freedom-loving miners would hardly submit to the rigid discipline exacted in Germany which would be absolutely necessary in stamping out the disease. At present, therefore, every possible precaution should be taken by a rigid exclusion from all the collieries of Great Britain of any one at all likely to introduce the terrible pest.

After describing very fully the conditions necessary to the birth, life and death of the *Ankylostoma*-parasite, Dr. Oliver gave excellent descriptions of the sanitary precautions taken, and the methods by which the excrement was examined in suspected subjects. He truly said that an examination by the microscope of the excrement was the only absolutely certain method of proving the existence of the disease, and if the eggs of the worm were not discovered, after repeated searches, the men might be declared to be free from the parasite. Now the microscopical examination of the stools was a tedious and troublesome as well as a disgusting proceeding and in order to obviate this a method of diagnosis had been advocated by Dr. A. E. Boycott, the Gordon Lecturer of Experimental Pathology at Guy's Hospital. Dr. Boycott in a *Report on the Diagnosis of Ankylostoma-infection* to the Home Secretary this year (Cd. 2066)

hat the examination of the blood was a quick means of
g out in a large number of men whether the disease were
it or not. Dr. Boycott had shewn that in 90 per cent. of
ases found in the Dolcoath tin-mine the eosinophile-
ytes in the blood numbered 8 per cent. and over of all the
leucocytes. Although an increase in the eosinophiles
lace in individual cases of asthma and in some acute skin-
es, etc.; if the men in a suspected colliery were examined:
0 per cent. of 400 or 500, they could have films taken of
blood in 20 minutes. Now, should there be an increase
eosinophiles of 8 per cent. and over in such a percentage
miners, then there were very strong grounds for suspect-
he infection of the men, and the stools should at once be
ined for ova. On the other hand, if a large percentage
n showed no increase of the eosinophiles beyond 5 per cent.,
resumption was very strong that no disease existed, or at
ents that the mine was free from extensive infection.
ot the least interesting part of Dr. Oliver's paper was the
nt of Dr. Looss, of Cairo, and the experiments which went
ove that the worm could gain access to the intestines
gh the skin. It appeared that the larvæ could pierce
kin, travel into the veins and onwards into the lungs,
hial tubes, windpipe, and then into the stomach: a most
erful journey indeed. This important discovery confirmed
uspicions of the Cornish miners that the worm got into
skin, because they suffered from a peculiar disease of the
of the hands which they called "bunches" The progress
o rapid that Dr. Looss said that the worms would appear in
ntestines two days after the larvæ had been applied to the
Hitherto, it had been thought that the only way by which
orm found its way into the intestines was by the mouth;
s, therefore, of great importance that the hands should be
free from any contamination in the mine.

r. J. S. HALDANE (Oxford) wrote that the very interesting
important micro-photographs exhibited by Dr. Oliver to
nembers placed entirely beyond doubt Dr. Looss' theory
in infection. Even so short a time as a year ago he (Dr.
ane) found himself to be a solitary upholder of this theory,
he went to consult the medical authorities on the disease
estphalia.

A further new point brought forward by Dr. Oliver was Dr. Looss' recent demonstration that the worms do not feed on blood. This was in accordance with his own experiments on Cornish patients, the result of which was to show that the so-called "anæmia" of ankylostomiasis was not due to loss of blood, but to great dilution of it with watery fluid, so that the blood volume was much increased.* It might perhaps interest members of the Institute to know that his investigations on carbonic oxide in coal-mines had led to the discovery by Prof. Lorrain Smith and himself of a simple method of measuring the volume of the blood in a living person. The method previously in use could only be carried out on decapitated criminals, while the new method involved nothing more serious than the administration of a quite harmless amount of carbonic oxide, and could thus be easily employed in the cases of some of the Cornish patients.

With regard to the eosinophilia which accompanied *Ankylostoma*-infection, he would like to point out the great practical significance of the recent researches of Dr. A. E. Boycott.† By smearing in the proper way a small drop of blood on a glass-slide, and afterwards examining this film microscopically, it was possible to determine the percentage of eosinophile white-blood corpuscles. Dr. Boycott had examined a large number of these films, including many sent to him by Mr. R. A. Thomas, the manager of Dolcoath mine, and Mr. J. C. Cadman, H.M. inspector of mines. Among normal persons about 0·5 to 5 per cent. of the white corpuscles were usually eosinophiles. Dr. Boycott found that in the case of three Midland collieries (Talk-o'-th'-Hill and Birchenwood collieries, North Staffordshire, and Snailbeach lead-and-zinc mine, Shropshire) where no trace of *Ankylostoma*-infection could be found, in no single case out of 94 men did the percentage of eosinophiles exceed 7·2 per cent., the average being 2·1 per cent. On the other hand at Dolcoath mine, which was thoroughly infected, out of 148 underground workers only 8 showed less than 7 per cent. of eosinophile-leucocytes, the average being 18·2 per cent. In less completely infected Cornish mines the results were intermediate. Among

* *Journal of Hygiene*, 1903, vol. iii., page 111.

† *Report on the Diagnosis of Ankylostoma-infection, with Special Reference to the Examination of the Blood*, [Cd. 2066] 1904; and more fully in the *Journal of Hygiene*, 1904, vol. iv., page 437.

14 surface-workers at Dolcoath, the highest percentage was 4·8: average 2·0. As a blood-film could be obtained in half a minute, whereas it was most troublesome to obtain a sample of fæces, Dr. Boycott's results showed that for ascertaining with very great probability the presence or absence of infection among miners the blood-film method was most valuable.

He (Dr. Haldane) had already expressed himself so frequently as to the general nature of the practical measures needed to prevent the gradual spread of *Ankylostoma*-infection in British collieries that he would not add more on this point. He hoped that the discussion on Dr. Oliver's paper would elicit information as to what was being actually done at different collieries, and particularly in what way underground pollution could be most successfully prevented.

Dr. Eustace Hill (Medical Officer of Health for the County of Durham) stated that the remarks of Dr. Oliver on the disease known as ankylostomiasis or miners' worm were of great interest to him, as the subject was one of considerable importance to the mining population of some parts of Durham and had received his close attention for some time past.

It could not be doubted that in certain pits in the north of England conditions were favourable to the spread of the disease when once it was introduced, and owing to its general prevalence in many parts of the world, and in so many mining districts in Europe, the risk of its introduction was obvious. From careful enquiries he had made in the county of Durham he had no reason to believe that the parasite had been introduced into any of the mining districts, and therefore the special measures mentioned by Dr. Oliver as having been taken in Westphalia were not, at any rate for the present, necessary in this county. It was, nevertheless, very important that both the colliery-owners and the miners should recognize the necessity for cleanliness in the mines, and especially in those pits where the temperature approximated to 70° Fahr.

It was the duty of the colliery-owners to provide conveniences in suitable positions down the pit, so that the workmen in case of necessity might use them instead of fouling the ground with their excreta. The receptacles would require to be periodically brought to bank, emptied and disinfected, and that there was

no serious difficulty in carrying out such an arrangement was proved by the fact that it was carried out in Germany and other countries. Conveniently-situated closets should also be constructed close to the mouth of the shaft, for use by the miners before descending to work. The need for the provision of suitable closets for the convenience of the workmen down the pits was very great, altogether apart from the question of ankylostomiasis, for, as county medical officer, he had on several occasions obtained evidence which satisfied him that the spread of enteric fever had occurred in certain districts owing to the fæcal pollution of the ground, etc., in the pits. The miners themselves should also be made to recognize that the habit of emptying the bowels on the ground was a source of trouble and danger, which should as far as possible be prevented. Where the owners had provided suitable conveniences, any miner causing fæcal pollution of the ground in the mine should be punished, and he (Dr. Hill) had no doubt that such punishment, when once the danger of the offence was recognized, would be approved of by the miners themselves.

He was glad to be able to state that both the mine-owners and workmen in the county of Durham recognized the necessity of precautionary measures against the introduction and spread of the *Ankylostoma*-parasite. Conferences of owners and men had already been held, and regulations drawing attention to the necessity of cleanliness on the part of the workmen were being drawn up, though up to the present he was not aware that steps were being taken by any of the owners to provide closets for the workmen in the pit.

Mr. John Wilson, M.P., Secretary to the Durham Miners' Association, had also done much good work in the county, by the distribution of information in the mining districts as to the nature and prevalence of the disease. The Durham County Council had taken similar action by calling the attention of the sanitary authorities in the county to the disease and the necessity for precautionary measures; and, with the object of assisting in prompt diagnosis of the disease, they had come to an arrangement with the Bacteriological Department of the College of Medicine of Newcastle-upon-Tyne for the examination of specimens of excreta from suspected cases, without any charge to the medical practitioner sending them.

Another preventive measure which should be adopted was he exclusion from our coal-mines of men seeking employment, ho had previously worked in infected mines or lived in infected ountries, until they had been proved by a proper medical xamination to be free from the parasite. That precaution was specially necessary in those pits where the conditions of emperature and moisture were favourable to the development f the *Ankylostoma*-worm.

In conclusion, he wished to point out that the facts demonstrated by Dr. Looss, as to the ease with which the disease could e inoculated through the skin (facts which had been independntly confirmed by other experimenters), were of very considerble importance, for it proved, as Dr. T. Oliver reminded them, hat cleanliness in the mine was as essential as cleanliness in he habits and persons of the miners themselves. In fact, if orkmen infected or likely to be infected were excluded from he pits, all the other precautions necessary could be summed p in the word "cleanliness."

Dr. J. W. Hembrough (Medical Officer of Health for the ounty Council of Northumberland) wrote that owing to the ell-ventilated condition of the mines in this county and conequent low temperature, no doubt the danger of *Ankylostoma*-ggs becoming developed into larvæ was greatly diminished lthough the risk of the eggs being deposited in these mines by iners who had contracted ankylostomiasis in other mines must e considerable. The possibility of any mine becoming infected ould only be insured against by the total abolition of defæcaion, except into specially provided receptacles. To bring bout this most desirable condition, two things appeared to be ecessary:—(1) The provision at the pit's mouth, and in the orkings, of a sufficient number of properly constructed recepacles; and (2) the co-operation of the men engaged in and about he mines.

Mr. Ralph Stockman (M.D., Professor of Materia Medica in lasgow University; Physician to the Western Infirmary) wrote hat he could add but little to what Dr. Thomas Oliver had said egarding the symptoms and causes of ankylostomiasis. It was form of anæmia which was now very widely spread throughut the world, and was known as miners' anæmia, Egyptian hlorosis, and by other popular or semi-popular names, accord-

ing to the locality or class in which it was prevalent. It was not the only anæmia that was due to an intestinal parasite worm, as along the Baltic coast a species of tape-worm (*Bothriocephalus latus*) gave rise to a very severe and sometimes fatal poverty of blood. Bloodlessness or anæmia was merely a symptom due to many underlying causes, and was a common result of many familiar diseases. In ankylostomiasis, the cause could be readily diagnosed by finding the characteristic ova of the worm in the fæces. The sufferings and symptoms of the affected persons arose, however, from the bloodlessness and not directly from the presence of the worms in the bowel. In temperate climates the ova developed into the infective larval form most readily under the conditions of warmth and damp which were present in mines, tunnels, and brickfields: hence, in Europe, men working in these places were most frequently, but by no means exclusively, affected. In warm climates, the ova flourished in the moist earth anywhere, and hence the agricultural classes and the rural population generally were very subject to the disease. Where the number of worms was small the host suffered little inconvenience, and if he were not further infected by swallowing fresh larvæ, the original worms died in about six years, and a natural cure resulted. He might, however, be a source of infection to others during all that time. The number of worms might amount to several hundreds, and in these cases the anæmia was always severe. Dr. Oliver had alluded to the different opinions held regarding the exact part played by the worm in causing anæmia, and on this point he (Dr. Stockman) might be allowed to express an opinion, as some years ago he made certain observations on the amount of iron contained in the livers and spleens of five persons who died of ankylostomiasis in Fiji and Ceylon.* It was found that the organs mentioned contained very little iron, and this pointed to actual loss of blood from the blood-vessels of the intestinal wall, rather than to the actual destruction of red blood-cells by means of a poison secreted by the parasite and afterwards circulating in the blood-stream. Whether the worms swallowed the blood, or whether there was merely bleeding from the punctures made by their hooks in the mucous membrane of the intestine, was a point which he had never had an opportunity of investigating. Drs. Loeb and Smith had found that the worms

* *British Medical Journal*, 1896, vol. ii., page 189.

ed a substance, which prevented coagulation of the blood, ence, their bites tended to bleed freely.*

e following short summary of a case which came under r. Stockman's) care in the Western Infirmary of Glasgow f interest, owing to the occupation of the patient and ct that he imported the disease from India, where he was g in the Army. He was a young man, 25 years of age, ng from severe anæmia, but otherwise healthy. He had ill for about two years, and dated his present condition an attack of inflammation of the bowels (enteritis) which tracted in India and for which he was treated in hospital know for two months. On his discharge from hospital he till weak and breathless, and after being three months off duty he was invalided home and treated in the military al at Netley for anæmia. He did not improve, and finally, s discharged from the Army as suffering from an incurable e of the blood. About the beginning of 1903, he returned original employment as a miner, and worked in a Lanark-coal-mine. He was never really fit for work, and had to t up. On admission to the Western Infirmary, his blood ound to contain an unusual number of the so-called eosino-cells, and numerous ova of *Ankylostoma duodenale* were in the fæces. He was treated with 20 grains doses of ol, and liquid extract of male-fern, and after sixteen days ore ova were found. Ten months later, one examination sed no ova, but six months subsequently a few ova were nt and there was some anæmia. He was put on thymol rains thrice daily) and the ova disappeared. At this time id a certain degree of anæmia, which rapidly improved. his first discharge from the Western Infirmary he worked ground as a fireman, and felt quite well. The long per-ce of ova in the fæces even after energetic treatment rates the great difficulty of getting rid of the worms, and strates that a man in apparently good health may still har-the parasites, and be a source of infection to his neighbours.

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Proceedings of the Pathological Society of Philadelphia, 1904.

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r. THOMAS OLIVER, in acknowledging the compliment, said he was only too glad to give the members the benefit of his

* *Proceedings of the Pathological Society of Philadelphia*, 1904.

experience, and to convey what information he could gather when abroad as to the mining industry of the districts named. Mr. J. B. Atkinson very properly spoke of the question of high temperature and dry air, for the dryness of the mines in the north of England was a safeguard from this disease. To be liable to the disease, there must be a fairly high temperature, and there must also be moisture and a supply of oxygen. There was no reason why the use of stationary appliances should not be adopted in the mines; it was interesting to know that in the mine, the coal-dust, always present, was a good antiseptic. If this were sprinkled on each fæcal accumulation passed, the deposit might be safely left, for it was not likely to give any trouble. Regarding the receptacles in the infected mines in Westphalia, there had often been a pretence on the part of the men to go towards the receptacles but not to use them, that in order to prevent the irregular disposal of fæces taking place, and infection being carried (because that was one way in which it had been carried), this particular part had to be sprinkled with lime, so that the miners being obliged to walk through the lime, their boots were thereby disinfected.* He (Dr. Oliver) had had an opportunity of seeing many of the Polish workmen in Ayrshire, and so far the disease had not been known to be introduced there by any foreigner, but this was one of the things against which they had to specially guard. At Nenthead, there was, of course, risk of infection from the Italian workmen. The members knew, as one gentlemen had stated in the discussion, that coal-mining was an extremely healthy occupation, but they could not say the same for metalliferous mining, for large numbers of metalliferous miners died from phthisis, a disease that was practically unknown among coal-miners.

* Since the reading of his paper, Sir Patrick Manson (*British Medical Journal*, 1904, vol. ii., page 1246) had made a practical suggestion for the "Prevention of Ankylostomiasis," and while it applied more particularly to the anæmia of coolies and what is known as pustular dermatitis or coolie itch, it would not be out of place to mention it here since the *Transactions* of this Institute are sent and read all the world over. West Indian sugar-planters had for long known of the coolie itch and the subsequent anæmia, and they had generally attributed the former to contact of the bare feet with fæcally fouled soil. Before allowing his coolies to work in contaminated fields, one sugar-planter got the coolies to dip their feet and legs in a bucket of green Barbadoes tar—a mineral oil rich in paraffin and cheap (3d. a gallon), and then to walk across and through fine sand. In this way an impervious sandal and stocking was donned every morning: and in practice, it was found to be most efficient. It was not for a moment contended that Sir Patrick Manson's suggested line of treatment was applicable to British mines and miners, but to managers of foreign and colonial mines the information might not be so valueless as at first sight it might appear.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING.

HELD IN THE HALL OF THE INSTITUTE, HAMILTON, DECEMBER 8TH, 1904.

MR. ROBERT THOMAS MOORE, PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting were read and confirmed.

The following gentlemen were elected:—

MEMBERS—

Mr. FRANCIS GEBBIE ALLAN, 17, South Hamilton Street, Kilmarnock.
Mr. JOHN BLAKE, Eddlewood Colliery, Hamilton.
Prof. JOHN WALTER GREGORY, The University, Glasgow.
Mr. WILLIAM MACKIE, Hirst Colliery, Salsburgh, Holytown.

DISCUSSION OF MR. JAMES C. WEIR'S PAPER ON A "FIRE IN A LANARKSHIRE COLLIERY, AND DESCRIPTION OF A CONDENSER USED THEREAT."*

Mr. ROBERT W. DRON (Glasgow) wrote that Mr. J. C. Weir's section of the strata of the Glespin coal-field differed considerably from the section of the No. 1 shaft, Glespin colliery, the paper by the late Mr. Robert Weir† and also from that given in the *Memoirs of the Geological Survey of Scotland.*‡ Mr. Dron) asked whether the new section was taken at a point some distance from the No. 1 shaft. Mr. Robert Weir mentioned a seam of Musselband ironstone lying below the Seven-feet coal-seam, and a shale corresponding to the position the Slatyband ironstone, below the Carmacoup coal-seam. These ironstone-bands, which are of great importance in correlating the seams, are not shown in Mr. J. C. Weir's section.

* *Trans. Inst M.E.*, 1904, vol. xxviii., page 19.
† *Ibid.*, 1899, vol. xvi., page 442.
‡ Explanation of Sheet 15, page 30.

Mr. J. C. Weir desires to identify the Glespin Seven-feet c
seam with the Ell coal-seam of Lanarkshire, but he br
forward no evidence to prove this correlation. The evide
so far, points to the conclusion that the Seven-feet coal-s
lies on a horizon corresponding with that of the Virtuewell c
seam of Lanarkshire, and that the underlying coals are on
same horizon as the Ayrshire seams lying between the Mus
band and Slatyband ironstones.

Mr. THOMAS THOMSON said that the observations made
Mr. Dron were so far correct, but the Seven-feet was certai
not the Virtuewell coal-seam. Mr. J. C. Weir, however,
not state why he differed from the previous writer (Mr
Weir) on this subject. He (Mr. Thomson) thought that
late Mr. R. Weir had been mistaken in supposing that
Musselband found in the Douglas Water, a little below
Glespin pit, was the Musselband lying below the Virtuew
coal-seam, instead of that lying above the Pyotshaw coal-sea
The Seven-feet coal-seam in Glespin pit, lying above t
Musselband, is the Ell coal-seam; the Three-feet seam, fou
below the Musselband, is the Pyotshaw seam of Hamilton; a
the Four-feet seam, at Glespin, is the Main coal-seam of Ham
ton. The Four-feet seam, at Glespin, contains a rib of st
in the position of the pugs or strong splint of the Main coal
the Hamilton district. The Nine-feet coal, at Glespin,
Splint-coal of the Hamilton district, and the Nine-feet seam
the Glebe colliery, at Douglas, are all the same seam. Ab
114 feet below the Glespin Nine-feet coal, lies the Virtue
coal, which has the shale roof found throughout the Airdrie
Slamannan coal-fields. About 30 feet farther down, is
Musselband found below the Virtuewell coal. The Carmac
and other seams of the Glespin coal-field are the seams ly
below the Virtuewell coal of the Airdrie and Slamannan distri

The PRESIDENT (Mr. R. T. Moore) said that Mr. Weir's c
denser was simply the application of a second cylinder, wh
took the place of an air-pump. He thought that the auxili
cylinder would do most of the regular pumping, and that
original cylinder would then only have to give that press
which was expected of an air-pump. This was somew
like the arrangement, which was now becoming rather comm

ely, to make the air-pump pump water from the lodgment
o a tank, whence it flowed into the suction of the pump.
here could be no doubt that the fire, which Mr. Weir had
ibed, had been largely caused by the heat of the workings
o steam being led into them. While condensing steam-
s were useful at the bottom of shafts, the tendency nowa-
was to dispense with them in the workings and use elec-
or some other means of conveying power which did not
e the conveyance of heat into the mine.

e discussion was closed, and a vote of thanks was awarded
author.

ROBERT CRAWFORD read the following paper on "Wind-
Minerals from Inclined Shafts":—

WINDING OF MINERALS FROM INCLINED SHAFTS.

By ROBERT CRAWFORD.

The winding of minerals from inclined shafts presents difficulties in the way of expeditious loading and unloading of the wheeled cage or carriage, vastly greater than any experienced with perpendicular shafts.

The success that has attended the use of the system adopted for the first time at Burghlee inclined mine, Loanhead, justifies, in the writer's opinion, the following detailed description of it:—

Burghlee colliery, the property of the Shotts Iron Company, Limited, is situated on the outskirts of the village of Loanhead, near the foot of the Pentland hills, and about 6 miles from the city of Edinburgh. The Burghlee seams occur in the Carboniferous Limestone Series, which contains numerous workable seams of coal and ironstone, interstratified with limestones, sandstones, and sandy shales. The strata dip eastward from the foot of the Pentland hills at a high gradient, and passing underneath the Coal-measures emerge again on the eastern side of the basin with a gentle westerly dip. At Burghlee, the inclination varies from 70 to 40 degrees, down to a vertical depth of 1,890 feet; there it abruptly changes to 25 degrees, and in some places becomes nearly flat. It is worthy of note that, at the abrupt bend, the coal has no appearance of being crushed, and is in no way different from the coal in proximity to it, on either side of the bend. The seams are won by means of a main incline, 6 feet high and 22 feet wide, driven in the Great seam, and following the coal from its outcrop at the surface to a depth of 1,620 feet on the slope or 1,200 feet perpendicular. The gradient of the incline varies from 60 to 45 degrees. This main incline is supported on each side and down the centre by brick-walls, 18 inches thick, forming two divisions, each measur-

6 feet by 8 feet. The roof is secured with wooden crown-trees, ng the ends built into the side-walls.

Description of the Old System.—Previous to the introduction ne new system, the winding-carriage had three fixed decks, h which tub-tracks were laid in a line parallel to the axis of the ned mine. Each deck was capable of accommodating two , containing respectively 6 cwts. of coal or 10 cwts. of iron- e. Each of the three decks was changed in turn at the same l—the carriage being raised or lowered as required. The age time occupied in winding the carriage and changing the was between 5 and 6 minutes. As three-quarters of the time ach wind was occupied in changing the tubs at the top and bottom of the incline, an attempt was made some years by means of an arrangement of separate landings and hoists, eal with all the decks simultaneously; but the cost of work- in that manner was so high that the attempt was abandoned. eing evident that no saving of time could be effected in al running, relief could only be obtained by a radical altera- of the arrangements at the top and the bottom of the ne.

Description of the New System.—The root-idea from which iew development sprang was a suggestion that the carriage arriages might be brought to a horizontal position at the and the bottom of the incline, and thereby facilitate the ging of the tubs by requiring only one setting of the age or carriages. The problem, thereupon, presented for ion was, how to maintain the tubs in the carriage con- ly on a level base, while the carriage was running on ients varying from 1 in 25 to 1 in 0·6.

he construction of the new carriage, which was designed has been patented by Mr. A. W. Turnbull, the general ger, and Mr. Henry Love, the colliery manager, is shewn in 1 and 2 (Plate VI.). The carriage has an outer frame of n iron, into which are fitted two curved tracks, ABC, having ius of 3·25 feet and a gauge of 3·7 feet, running parallel to the of the inclined mine. Upon these curved tracks travel the orting-wheels of two movable decks, each capable of accom- ating one tub. These decks, having free travel relative to

the carriage-frame, will always maintain a horizontal position; for, owing to the action of gravity, the centre of oscillation and the centre of gravity will remain vertical, irrespective of the inclination assumed by the carriage-frame; and, consequently, the tub is always standing level on the carriage. The decks are extremely sensitive to any change of gradient in the carriage-way, and respond instantly by moving into the position appropriate thereto. Each movable deck is fitted with rails laid transversely to the carriage-frame and so adapted as to be brought into alignment with the rails at the top and the bottom and at any intermediate level in the incline, in such a manner that the

FIG. 9.—CARRIAGE PASSING FROM A GRADIENT OF 1 IN 0·58 TO A GRADIENT OF 1 IN 20.

tubs may be conveyed from the decks to their destination and *vice versa*. One of these rails, D, projects across the carriage-frame, and acts as a stopper for the movable deck, when the carriage-frame assumes a horizontal position; while a cross-bar, E, with channel-shoes, forms a stopper at the opposite end of the curved track, should the carriage-frame assume an almost perpendicular position.

Two carriages, coupled together by a central draw-chain, 3·5 feet long, and safety-chains on each side, deliver at the

surface four tubs per wind, containing on an average 36 cwts. of mineral.

Figs. 3 and 4 (Plate VI.) shew, in elevation and cross-section, the surface-arrangement, where the carriage-ways are laid at an inclination of 1 in 20.

In order to facilitate changing, the full tubs are only taken off on one side of the incline; and the empty tubs, which are elevated from the screens by means of a creeper-chain to a height sufficient to enable them to gravitate round, are pushed on to the decks from the other side of the incline. To accomplish this, it was necessary to provide a reversible bridge, to span the

FIG. 10. CARRIAGES, COUPLED TOGETHER, AND REVERSIBLE BRIDGE.

carriage-ways alternately, and having its axis placed between the two carriage-ways. This reversible bridge is fitted on both sides with rails, with which the rails on the decks are brought into alignment when the carriage arrives at the surface. In the meantime, the reversible bridge is operated by a hand-crane and counterbalance-weights, but eventually it will be worked automatically by gearing, driven by the winding-engine (Figs. 5 and 6, Plate VI.), and rotated into position during the time of winding, so as to be placed in readiness for the ascending carriage.

Figs. 7 and 8 (Plate VI.) shew, in elevation and plan, arrangements at the bottom of the incline. By a common cr ing, the carriage-ways converge into what is practically a sin line between the platforms, at which the decks are brought i alignment with the underground tracks. At these platfor the carriage-ways are laid at an inclination of 1 in 25, separate rails of each carriage-way are placed 3 inches ap and each carriage remains on its own rails, thus avoiding risks inseparable from the use of movable points. The arra ment possesses the further advantage, that the rails of e carriage-way act as guide-rails to the other.

The direct-coupled horizontal winding-engine has cylinders, each 32 inches in diameter by 5½ feet stroke, supp with steam at a pressure of 50 pounds per square inch. drums are 13½ feet in diameter. The ropes are 1¼ inche diameter. The working-load, including the weight of the r is 5 tons.

The time required for changing the tubs is only 15 seco and a wind can now be accomplished easily in 81 seconds. saving of 219 seconds per wind has been effected, as compa with the time under the old system; and this is equival to an increased output of 400 tons per day of 9 hours.

Conclusion.—The system practically eliminates all difficult arising from variation of gradient, and enables mine-owners raise by an inclined mine an output approximately equivalent that got from a perpendicular shaft. Possibly, one or two ex men may be required at the top and the bottom of the incli mine, in addition to those that are necessary for the same c put from a perpendicular shaft; but, on the other hand, s stantial gain is secured in the reduced expense for pumping the avoidance of intersection of the strata by a vertical shaft. one case in the company's own experience, the growth of w in a mine, 1,200 feet deep, won by an incline did not amoun 50 gallons per minute. The difficulties of winding were, h ever, so great that an attempt was made to sink a perpendic shaft; but when it was found that the growth of water fr strata intersected therein, at a depth of 300 feet from the surf exceeded 1,500 gallons per minute, the attempt was abando

Any required number of carriages can be run in a tra

but the number of decks that can be fitted into each carriage depends upon the gradient of the incline, as the higher the gradient becomes, the more space is required for the free travel of the movable decks. It may be confidently predicted that this new system will give an impetus to the working of highly inclined, or, as they are sometimes termed, edge seams, by means of inclined mines, which have up till now been in great disfavour, principally because of the difficulty of getting a satisfactory output from them.

Mr. JAMES RODEN read the following paper on "Coal-mining in Borneo":—

COAL-MINING IN BORNEO.

By JAMES BODEN.

Borneo, the largest of the East India Islands, is situated on the main sea-route to China and Japan. At one time, the whole of the island was under the despotism of the Sultan of Borneo, but during the last 60 years, there have been internal changes, and the power of the Sultan has been curtailed. At the present time, the North Borneo Company, Limited, rule over many thousands of square miles of territory, and carry on various forms of industry, including the mining of gold, silver and coal. An Englishman, Rajah Sir Charles Brooke, K.C.M.G., has established his rule over fully 50,000 square miles of country, with a population of over 1,000,000 people. The writer obtained his knowledge of mining in Borneo, while in the employment of Rajah Brooke.

The island enjoys perpetual summer, but the heat is very oppressive, and renders Europeans utterly unfit for manual labour. The average temperature at night is 85° Fahr., and during the day it sometimes attains 120° Fahr. in the shade.

Sadong Coal-mines.—The Sadong coal-mines have been working, more or less, for nearly half a century, and are owned by Sir Charles Brooke. Three coal-seams, which crop-out on the hillsides, have been worked by day-light mines. The thickest seam has the following section:—Roof of soft shale, 3 feet; coal, 9 inches; dirt-parting, 10 inches; coal, 2 feet 2 inches; and fire-clay 4 inches. The seam contains 3 feet 2 inches of coal in a thickness of 4 feet 4 inches of working. The other seams are 22 inches and 20 inches thick respectively, the latter resembling in thickness, as they do in nature, structure and form of deposition, the Ladygrange seam of the Slamannan coal-field. These coals were tested in Singapore for gas-making purposes in 1872, and yielded over 10,000 cubic feet of gas of good illuminating power, and about 6 cwts. of good smithy-coke per ton of coal consumed in the gas-works. The analyst reported that the coal was well adapted for gas-making and steam-raising purposes.

), 350 men were employed at these mines—comprizhinamen and 69 Malays. Chinamen are the great the East: Malays are not fond of hard work, but with ervision they make useful, handy, oncost men. The loyed two Malays as *mandors* or oversmen.

ong, the seams, being thin and flat, were worked by ll system. The work was divided: one set of men places, a second set of men stripped the places, and of men acted as drawers. The holers were paid 40)d. for holing 8 feet along the face to a depth of 2½ ents or 7½d. for holing to a depth of 2 feet; and r 5d. for holing to a depth of 1 foot 7 inches. The ere paid 40 cents or 10d. for baring 20 feet of wall- drawers were paid from 3 cents or ¾d. to 5 cents or utch of 7 cwts., according to the length of the road Prop-setters were paid 15 cents or 3¾d. per set of es, comprizing two posts and a crown-tree. The ere paid 1 dollar 60 cents or 3s. 4d. per fathom for nickness of 3½ feet of stone.

), the 350 men employed at the Sadong colliery only etween 60 and 65 tons per day. The average output nployed over a considerable period of time is only 3½ day.

on Coal-field.—Three days' sail northward along the n Kuching, the capital of Rajah Brooke's dominions, a more important and interesting coal-field known to as "Muara," but it has been lately called Brooketon, wner, Sir Charles Brooke. This extensive coal-field in northern Borneo. The colliery is reached by about ailway, and the traffic is worked by a small, specially- notive. There is a splendid bay, at Muara, giving rage to steamers. A wharf for loading and sheds the coal have been erected at the water-edge. Vessels tween Singapore, China and Japan call here occasion- al.

are six coal-seams in this district, that have been many miles inland, and it is believed that they stretch 20 odd miles of water separating Brooketon from the Labuan, where coal is being worked at present by the

Borneo Company, Limited. The seams are of the following thickness, and are entirely free from dirt-partings:—1 foot 2 inches, 4 feet, 3 feet, 26 feet, 24 feet and 16 feet respectively (Fig. 1, Plate VII.). The distance between the 16 feet seam and the 24 feet seam is about 120 feet; the distance between the 24 feet and the 26 feet seams is about 150 feet. Only the 26 feet seam was being worked at the time of the writer's visit.

There has evidently been great disturbance of the earth's crust, as the seam, at this particular part of the field, has, apparently, been reversed; for, contrary to common experience, the roof is a thin bed of fire-clay, and the floor is a post of hard sandstone. The inclination of the seams varies greatly: at the mine, it is about 63 degrees from the horizontal, ½ mile inland it is about 30 degrees, and 2 miles from the colliery it is only 15 degrees.

The colliery comprizes one oblong vertical shaft, and two main dooks, driven in the solid coal (Figs. 2 and 3, Plate VII.). The shaft was sunk in a bed of blue till, lying above the thick fire-clay, already mentioned. There was no water got in the sinking, until the coal was struck: water then rushed in, and to prevent the loss of the untimbered part of the shaft, engine-ashes were thrown in from the surface to fill up this part. A bucket-pump 12 inches in diameter having been fitted, the water was pumped out, and the shaft was secured with a strong wooden lining.

From the bottom of the shaft, two levels were driven in opposite directions, and both in the solid coal. The levels met two bottom-levels, coming from the main dooks, driven in the solid coal. When communication had been made, a water-way for the colliery had thus been established: all the water finding its way to the bottom-levels, along which it travelled to the shaft-bottom, whence it was pumped to the surface.

The dooks (Fig. 3, Plate VII.) were driven from the surface in the solid coal and near to the pavement-side. When the dook had attained a depth of 30 to 40 feet, so as to leave coal overhead for a roof, as well as to prevent surface-subsidence, narrow bolt-holes were driven from the side of the dook, and formed the entrance to the different levels. As the dook was driven downward, bolt-holes were made at intervals of 12 feet,

and levels were driven in opposite directions along the seam. These levels were made 6 feet square, and were driven so as to meet levels coming from the other dook.

The levels were driven in this manner so as to form communications between the dooks, by the series of levels; and, starting half-way between, to pierce the coal from the lowest to the highest level of the series, and to work the coal back towards the dooks, by lifts between the levels. Up to the time of the writer leaving the district, none of the pillars had been removed: mining operations having been confined to the driving of solid places. In removing the pillars, considerable difficulties would be encountered; the safety of the workmen, who were practically unskilled, had to be secured; and the subsidence of the surface had to be guarded against. The rainfall at the Equator during the rainy season is very great, and if there were subidences at the outcrop, the water would penetrate into the workings in such quantities as to flood the colliery.

A simple, yet, in the opinion of the writer, a good and effective plan for preventing subsidence was proposed by Mr. John Robertson, who had charge of this colliery for some years. As sand and loose earth were plentiful at the entrance to the mines, and could easily be filled into hutches and sent down into the different levels, Mr. Robertson proposed that when stooping began the hutches should be loaded with this sand and earth, sent into the mine, and tipped into the space made in extracting the pillars, as shewn at A (Fig. 4, Plate VII.), illustrating the method of taking out the stoops.

The proposed method of removing the stoops or long rances of coal, formed in driving the levels, was as follows:—When the men in the lowest level of the dook had holed through to each other, they pierced upward through the 12 feet of coal between it and the next level. The place was then opened to the full thickness of the seam, and thus formed a face of coal, 26 feet by 12 feet, to work towards the dook. When the face had been advanced a few feet from the starting-point, sand was to be tipped from the second lowest level into the space made by the men in the lowest level. Then the men in this second lowest level pierced upward into the 12 feet of coal between it and the next level, and opened out this place to the

full thickness of the seam, and then they also had a face of coal, 26 feet by 12 feet, to work towards the dook. The rest of the levels followed the same process, up to the top, leaving only the thick pillar or rance at the top, for surface-protection. Sand was not required in the lowest level, but in the next level up to the highest, sand would be required to fill up the cavity formed by the removal of the coal. The sand, thus inserted, would slide or fall from level to level, and would completely fill the vacant space. It would prevent the collapse of the hanging-wall, and would also afford a safe footing for the miners while working in the various levels. This system would protect the lives of the workmen; it would be possible to remove nearly the whole of the coal; and surface-subsidence would be prevented, and the chances of the mines being flooded by torrential rains would be very greatly decreased.

The coal at Brooketon colliery is of good quality; it burns with a good flame and strong heat and leaves a fine brown ash. It is shipped to Singapore, and sold there in competition with Welsh and Japanese coals. Unfortunately, it is liable to spontaneous combustion. A somewhat remarkable instance of this came under the notice of the writer. About 18 months before he took charge of the Brooketon colliery, a fire had broken out in the two lowest levels communicating with the shaft; and the water had been allowed to rise and flood the levels, so as to extinguish the fire. When the water had been pumped out, a start was made to work some coal from these levels, but the second day's operations revealed the fact that fire had again started, and work had again to be abandoned.

The output, when levels were being driven, amounted to about 4½ cwts. per day per man employed at the colliery. It is probable that, when stooping is properly started, the output will be trebled, and the cost will be considerably reduced. The coal, too, will be more valuable, as it will contain a higher percentage of round, and the chances of spontaneous combustion in transit to Singapore will be diminished.

Labuan Colliery.—The Labuan colliery of the North Borneo Company, Limited, is situated on the island of Labuan, and in 1896, about 4,000 people, mostly Chinamen, were employed there.

es are reached by about 7 miles of railway, from the ibuan harbour; and the traffic is worked by three omotives of British manufacture. At one time, five ere employed, comprizing a manager, two assistant- n engineer and a platelayer.

ast, dooks were driven everywhere and anywhere, riven too high and too wide, with the result that they losed and were then abandoned by the Chinamen. us dooks driven from the outcrops on the hill-sides, iany waterways into the seam, and with the equa- he flooding of the mines with all its consequent loss iization was of frequent occurrence; but, when the he colliery, a well-defined and scientific method of coal-seams had been adopted.

seams—2 feet, 3 feet, 4 feet and 8 feet thick —crop out on the hillsides at angles varying from 15 es from the horizontal. Only the 8 feet seam was l at the time of the writer's visit. The colliery com- long shaft, about 180 feet deep, sunk from the sur- y hard post of rock; and four main dooks driven in l from the outcrop.

iaft, there is a winding-engine with two horizontal ch 22 inches in diameter and 3½ feet stroke. There condensing engine, with a cylinder 28 inches in 4 feet stroke, working a bucket-pump 18 inches in direct-acting steam-pump, with a cylinder 22 inches working a ram, 7 inches in diameter, is placed in m: and two water-chests, each holding 45 cwts. of e fixed on the cages in any emergency.

s are driven in the most favourable situation, and iery has been erected at each to haul out the coal. es are used in the levels; and large hutches, hold- each, are used in the dooks. The small hutches the levels, and are brought out to the side of the ipties into the large hutches.

iod of working the seam is as follows:—The dooks i the solid coal from the outcrop, and, right and left oks, levels are broken away. The levels are driven t apart, and of a height and width such as to allow hutches passing. Sufficient coal is left to form the

roof, and as much is left on the floor, so as to prevent the pave ment from heaving. No timber is required, and accidents ar e of very rare occurrence.

When the levels are holed through, the place is at onc e opened out to the full thickness of the seam, and the 30 feet o f coal lying between the two levels is brought back by a homewar d working towards the side of the dook, which is protected by a pillar of coal. At Brooketon colliery it was necessary to wa it until the lowest level of the series had holed through befo re stooping could be started, but at Labuan colliery the stooping w as begun as soon as the second and third highest levels of the seri es had holed through. The stooping is accomplished without inte r fering with the driving of the lower levels, or in any w y endangering the lives of the workers. A thick barrier of coal is left near the surface, to prevent subsidence and to avoid serio us inrushes of surface-water. In the bringing back of the c al towards the dook, no timber is used, the roof being allowed to close in behind the retreating line of working-face. Practica lly every ton of coal is extracted in fair marketable condition.

The same process of driving levels and taking out the sto ps is continued as far down as the dook extends.

The method of working the coal at Labuan colliery appe rs to be very safe. It is also inexpensive, when compared with p re- vious methods of working the coal, and it is well suited to t he prevailing conditions.

The output at this colliery averaged about 4½ cwts. per da y per man employed.

Prior to 1896, two Russian cruisers inspected the harbo rs of Brooketon and Labuan, and some of the officers stated t hat it was the intention of their Government to utilize the harbo rs as coaling-stations for their China squadron.

Labuan furnishes a good steam-coal, resembling in na re and fracture, as near as may be, the Upper Drumgray of the Monklands and Longriggend districts.

At Sadong, at Brooketon, and at Labuan, wood is plen ti ful and cheap.

Labour.- The supply of workmen is abundant. China men flock to Borneo: the majority are tall, strong, hardy and our-

fellows, capable of enduring much fatigue in a climate that is enervating to Europeans. They are generally respectful and docile to superiors, and they are grateful for a favour or a small kindness shewn to them. They have their faults, but with careful watching they make good miners. The Malays, or natives, are puny fellows, compared with the Chinamen, and few of them care to dig coal. They are more inclined to labour at light oncost work, at a fixed day-wage.

The Dyaks and Kadyans confine themselves to trading with the workers about the colliery, and it is seldom that any of them ask for work about the mines.

The Mexican dollar circulates in Borneo and its exchange value varies very much: sometimes it is worth 3s. 6d.; and at other times it may be worth only 1s. 9d.

The following may be taken as a fair average of the wages of the different workers:—Good miners, 50 cents or 1s. 0½d. per day; blacksmiths, joiners and enginemen, 40 cents or 10d. per day; general labourers, 25 cents or 6¼d. per day. The price fixed with a man on January 1st satisfies him until December 31st. There are standard rates for nearly every description of work, and no increase is asked on these by the workers. The mines are kept going for the seven days of the week. The workers, however, are staunch believers in an 8 hours' working day, and nothing will induce them to work longer hours. They start at 7 a.m., stop for breakfast at 11 a.m., resume work again at 1 p.m., and stop for the day at 5 p.m.

The President (Mr. R. T. Moore) said that the labour-question was an interesting one. The low rate of wages paid, however, seemed to correspond with the low amount of work given in return. At some mines in Germany, a method of filling the wastes with sand, resembling that described by Mr. Roden, had been adopted. The sand was run in with water, a thin rib of coal being left to keep up the sand.*

Mr. J. Fordyce Balfour said that, in Sumatra, the rainfall was over 200 inches a year; on some days, 4 or 5 inches of rain fell in about the same number of hours; and when rain

* *Trans. Inst. M.E.*, 1904, vol. xxviii., page 325.

descended in such quantities no pumps could face it, especially in open-cast workings on the side of a hill. They were working a gold-reef in Sumatra, at an inclination of about 60 degrees, and the full width of the reef was stoped from the surface downward. There, the heavy rainfall did not cause much trouble, as the water which ran into the mine was removed by an adit-level. The coal-seam, in Borneo, had a soft roof and perhaps a soft pavement; and he thought that it would be necessary for stoops to be left in as a protection. The conditions of labour were similar in Sumatra to what they were in Borneo, Malays making the best miners, while Chinese labour was used on oncost work. Drilling, in an underhand stope, cost 1s. for 4 feet. The ore was loaded by Chinamen, who were paid 40 cents or 8d. a day, while miners were paid 60 cents 1s. a day.

The further discussion was adjourned.

The SECRETARY, on behalf of the Council, gave notice of proposed alterations of some of the rules.

MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.

GENERAL MEETING.

HELD AT THE ROYAL VICTORIA STATION HOTEL, SHEFFIELD, NOVEMBER 8TH, 1904.

MR. T. W. H. MITCHELL, PRESIDENT, IN THE CHAIR.

The minutes of the previous General Meeting were read and confirmed.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

Mr. HORACE SANDERSON, Mechanical Engineer, Boyne Engine-works, Leeds.

Mr. ROBERT DEPLEDGE, Engineer Surveyor, 19, Salisbury Avenue, Armley, Leeds.

Mr. J. W. PEEL, Colliery Manager, Brancepeth House, Thornhill, near Dewsbury.

Mr. WILLIAM HERBERT LEWIS, Assistant Mechanical Engineer, Beech Grove, Whitwood, Normanton, Yorkshire.

Mr. MATTHEW CHARLTON, Mechanical Engineer, Poplar Cottage, Whitwood, Normanton, Yorkshire.

Mr. MOSES HOBSON, Colliery Manager, Beech Grove, Whitwood, Normanton, Yorkshire.

Mr. HAROLD W. SEYMOUR, Engineer and Chemist at Bye-product Plant, Rotherham Main Colliery, Rotherham.

Mr. ROBERT WATKIN, Colliery Manager, Dearne Valley Colliery, Little Houghton, near Barnsley.

Mr. JULES BOLLE, Ingénieur au Corps des Mines, École des Mines, Mons, Belgium.

Mr. SIMON STASSART, Ingénieur Principal au Corps des Mines, École des Mines, Mons, Belgium.

Mr. JOHN FLETCHER ARCHER, Mining Engineer, 32, Church Street, Sheffield.

ASSOCIATE MEMBER—

Mr. A. J. CRESWICK, Gatefield, Sheffield.

ASSOCIATE—

Mr. GEORGE WALKER, Under-manager, Hickleton Main Colliery, near Rotherham.

STUDENTS—

Mr. CHARLES HENRY HOBSON, Pupil to Mining Engineer, Beech Grove, Whitwood, Normanton, Yorkshire.

Mr. FRANCIS WHITWORTH WRIGHT, Pupil to Mining Engineer, Whitwood Collieries, Normanton, Yorkshire.

Mr. AUGUSTUS JOHN KENNEDY, Pupil to Mining Engineer, Whitwood Collieries, Normanton, Yorkshire.

The PRESIDENT (Mr. T. W. H. Mitchell) delivered the following address:—

PRESIDENTIAL ADDRESS.

By T. W. H. MITCHELL.

thank you for having elected me to the position of ident of the Midland Institute of Mining, Civil and anical Engineers, and I greatly appreciate the honour that have conferred upon me. It seems a happy climax to the y years that my family have been connected with the agement of the Institute. It is, however, with mixed feel- that I look back on the many changes that have taken place e *personnel* of the Institute since my father was elected tary in 1879; so many old and personal friends have d away, who would have appreciated the honour you have to their friend's son in electing him to the chair.

t the beginning of my secretarial duties in 1890, the ber of members, including honorary members, was 174, the output of minerals for the year ending December 31st, , in the Yorkshire mines-inspection district was 22,457,749 . At the end of our last financial year, the number of bers was 305, and the output for the year ending December , 1903, was 29,168,792 tons. So many tables of statistics put before you by the press, that I hardly think it worth e to wrestle with these at the present time; but it seems e that this Institute must have been doing good work creating an interest in acquiring information, when it und from the above figures that at the present time there e member for every 96,000 tons of output, while in 1890 was one member for every 129,000 tons of output. I do ind that there is a corresponding increase in the interest, r as contributing to the deliberations of the members of the tute is concerned, as I notice that at the date of the Annual ing in 1890 twelve papers were reported as having been before the Institute during the preceding year, against five ioned in the last report, although the Council in their al reports refer to the scarcity every year, and frequent nders are sent out to the members during the year.

Past presidents, in their addresses, have touched so ably on the various difficulties and troubles met with by mining engineers that there does not appear to be very much left for me with which to deal. This applies more especially to a very excellent address lately delivered by our last President to the Institute, in which mining was brought up to the present day and the present was very ably contrasted with the past.

With regard to the future, I find it most interesting to read the reports issued by the present Royal Commission on Coal-supplies and to consider the different opinions given with respect to the continuation of the British coal-industry, and the best methods of dealing with it now and in the future; but when all is said and done, it appears to me that the subject is all reduced to a question of £ s. d. The better seams have been, and always will be, worked first. Nobody, in my opinion, can appreciate the full the mineral wealth of this country at the present time because each succeeding exhaustion of a good seam appears to produce extra exertion on the part of the workers and users in dealing with the next best seam, most probably found at greater depth. This all points to the fact that mining institutes must and should increase in value, if members will only give expression to their experience in meeting and dealing with the difficulties caused by the working of the deeper and lower seams, which, probably, require a large increase in the capital expenditure for their development.

In connection with these deeper, and probably inferior seams, the risk of the worker appears to be very much greater than in the past, and the question of the terms of the lease and the system of making such a lease should be very carefully considered. The probable variation of the section and the quality of these other seams renders it necessary that the mining engineer should safeguard himself by obtaining reasonable clauses for enabling a reconsideration of the terms of his lease. I especially refer to this question, as I find that much capital is laid idle by the payment of long minimum rents in such a way that collieries have not the full opportunities which they should have of being developed. When dealing with these lower and worse seams, if safeguards are not made to keep down minimum rents and standing charges, the difficulty of working these seams will be very considerably enhanced.

Another point in regard to this question, is the unsatisfactory method of arranging terms with the men for working the coal. At the present time, there is very little inducement for the development of other seams, as the case generally is, that a hard-and-fast price-list is made, which more often than not is extremely in favour of the men, and is practically unalterable except by means of strikes or lock-outs. This, in my opinion, could be avoided if temporary arrangements, of fairly long duration, could be made. Such arrangements could be revised, at stated times, on the basis of the experience gained during the period of trial.

In connection with the Royal Commission on Coal-supplies, it is interesting to read the opinions given as to the causes of gob-fires. Some engineers state that depth is not a cause, and others that it is; others allege that pyrites has an influence, and yet others the contrary; again, others say that dry coal is more liable to spontaneous combustion than damp. I believe that the experience gained by our members, as shewn by papers, is that pressure and friction, say, against pillars and sides, are the chief causes, coupled with carelessness in leaving timber buried in the gob. I think, however, that a good discussion might be held upon this question, which in my opinion is a very important one.

One's own difficulties generally appear to be more important than those of other people. I venture, therefore, to mention a difficulty that has had to be faced at our own collieries in a most crucial form since 1895, that is, the rise-water question in the South Yorkshire district. The water is being dealt with at the present time, but as the thick-coal pits become exhausted, the head standing against the remaining collieries is gradually increasing, and it is therefore becoming essentially necessary that ample provision should be made to safeguard further developments.

It would be idle on my part to remind you of the various alterations in mining laws made whilst I have been secretary of the Institute, as regards explosives, timbering, compensation to workmen, etc. Thanks to the efforts of members of this Institute, it has been definitely decided that a testing-station for explosives shall be opened for the Yorkshire district; and this will no doubt form an additional factor of safety. In

connection with timbering, on referring to the first president
address given to the Institute in 1869, I find that the late
T. W. Embleton called special attention to the loss of life un
the heading of falls of roof; and during the past year a pa
has been read dealing with systematic timbering by H.
inspector of mines for this district (whom we are going to lose
his appointment as chief inspector of mines in India), wh
will call for your serious discussion this afternoon. There
one death for 1,226 persons employed and one for 335,000 t
drawn from 1872 to 1881; and one death for 2,005 pers
employed and for 546,000 tons drawn from 1894 to 1903, sh
ing that, if the matter is carefully considered in the future
managers and men, there should be a further reduction
this very serious cause of loss of life. I think that at
collieries we are hardly as systematic as we might be, in
matter of calling the men's attention to the responsibility re
ing upon themselves in respect to this serious loss of life. M
do not, I think, at all times take the same care that they mi
do: for instance, if it comes to a question of taking out a d
cult prop from a hard place in the gob, instead of protect
themselves by an advance-prop, they will do their best to pu
out. Almost invariably they pull something on to the to
themselves, and I consider that the management can hardly
blamed for such accidents.

The rules for recovering collieries after explosions have b
fully discussed in the *Transactions*, but there is now establish
not far from this room, a rescue-station, where qualified m
are instructed in the use of pneumatophores and other app
ances, enabling them to work in noxious gases; and the pap
that you will hear read to-day will give you the results of t
efforts of members of the Institute in this direction. I belie
that most of you will soon be asked to take this matter
financially and practically, more or less on the lines of the a
mirable papers and discussions that have been before you
previous meetings.

There is another instance, in which this Institute has tak
a leading position in improving the safety of the mine. So
years ago, a series of experiments were made upon safety-lam
and there is no doubt that the report drawn up by Mr. C.
Rhodes and others was a very useful guide to those who
charge of the management of collieries.

Many of these improvements have entailed increased cost, which have to be dealt with when working seams of inferior quality at greater depths, and there is less to meet these expenses than out of the thicker and shallower seams. There are, however, compensations for nearly everything, and it will be found that the loss of life is being minimized by these provisions, and that the great progress that has taken place in electrical machinery and air-compressing plant will assist very considerably in reducing costs in the pit; while, on the surface, the excellent arrangements that are now provided for washing and dealing with the coal, will considerably reduce costs there.

Next to working coal cheaply, the manufacture of coke and the extraction of all possible products out of the coking coal seems to be a panacea for the ills that attend the working of lower-grade seams, and it would therefore be very instructive if some member, having experience of retort-ovens and bye-product plants, would give a paper furnishing the commercial results of the process in this district. It is true that a paper has been read on the construction of retort-ovens. This information has been given in other districts, but as the constituents vary in various seams, the results of treating local coal-seams will be more interesting. Information as to the utilization of the waste-gases in gas-engines would also be interesting. This method of power-production seems to be coming into use, and it almost makes one think that the time of perpetual motion has arrived: if some power be applied to draw the first lot of coal out of the pit for the ovens, the ovens will supply the rest until the exhausting of the colliery-royalty.

With increasing depths and thinness of the seams, ventilation will probably form an important problem, and as the air will have to be carried through long distances, for shafts will not be sunk so frequently as now, it will probably be found that electrically-driven subsidiary fans will be of great use. I know that they have already been used, but the effect on the ventilation has not been described to the Institute, and I think that this information would prove most useful to members.

Further, the increasing depth of the seams raises the question of the method of winding, which forms subject-matter for grave consideration. I think that the more simple the engine, the better; although compound engines have their

champions, and electric winding has its friends. This last method has been tried in this district in a small way: and, a a paper has been promised upon it, there will doubtless be an interesting discussion.

Another serious question in regard to deep mining, is tha of winding-ropes. The great depths require that large output must be drawn, and if the men gain an 8 hours' day, the outpu must be drawn in a very short time. This necessitates heav loads, high speed and quicker banking, with its attendant sudde checking of speed, all placing great strains on the ropes an calling for greater size of ropes and consequent increase in de weight. It would be interesting if a paper were read shewi how this can be accomplished with the least loss of useful effe A suggestion has been made that, now that large-sized sha are the fashion, the weight to be drawn should be divided as to have two windings in one shaft, and the upcast shaft u more or less exclusively for the drawing of men and sto I think that a very instructive paper could be read on wi ing-ropes, shewing the progress made from the time when ha drawn iron-wire, with a breaking strain of about 28 tons per square inch, was used; next, how Bessemer steel was used; and the quality of steel that is now used with a breaking-strain up to 110 tons per square inch. In connection with this subject I think that some engineers scarcely realize the strains to which ropes are subjected. Most likely, an indication would be given in such a paper of the immense strains applied to a haulage-rope at the present time, when a block takes place in the engine-plane, or full and empty corves are locked together on the endless-haulage system, and the pit-corporal thinks that the best way of clearing the stoppage is to apply the full power of the engine. Personally, I have often been surprised at what the rope is expected to move, and should very often have liked to measure the strain exerted. The questions of the make of winding-rope, the re-capping, the greasing, and the changing of the same, all form subjects suitable for practical discussion.

Since the last Presidential address was delivered, the Coal Mines Regulation Act has been amended, so as to allow those offering themselves for examination for certificates to produce college-diplomas, and I am glad to see that the colleges in which we are especially interested are on the Home Office List.

I have no doubt that this concession will be useful to many student mining engineers, and that they will avail themselves of the excellent tuition now being provided by the two local colleges.

I am afraid that I have detained you a long time, but if my cursory address results in any new papers being read or in any discussion being opened out in this Institute, I shall feel that my object has been attained. With your assistance, I will use my best efforts to ensure that the Institute does not suffer through the honour that you have conferred upon me, and for it I again thank you.

Mr. G. Blake Walker, in proposing a vote of thanks to the President for his address, said that the Council had passed a unanimous vote of thanks to Mr. Mitchell for the 14 years' work which he had devoted to the interests of the Institute; he was sure that every member felt as strongly as the Council did, that he had put them under a great debt of obligation; and he felt that in welcoming Mr. Mitchell as president, they should not forget to thank him for his services as secretary.

Mr. W. H. Pickering seconded the resolution, which was unanimously adopted.

The President (Mr. T. W. H. Mitchell) stated that Mr. L. T. O'Shea, of the Sheffield University College, had been appointed secretary.

Mr. M. H. Habershon read the following paper on "The Work of a Joint Colliery Rescue-station":—

E WORK OF A JOINT COLLIERY RESCUE-STATION.

By M. H. HABERSHON.

The reasons for the establishment of joint colliery rescue-stations and their constitution and scope were discussed by the writer in a paper contributed in March, 1901.*

Briefly stated, it was urged that groups of collieries or pits in the same immediate neighbourhood should have at hand, and always available, means by which a small number of trained men would be able to penetrate a noxious atmosphere for the purpose of exploration, and to perform such light work as the fixing of sheets or temporary stoppings, opening or closing doors, and the carrying-out of injured or helpless men, and that this would only be possible by the provision of improved pneumatophores, portable electric lamps, and a station at which men could be regularly trained, oxygen and other necessaries kept, and the apparatus maintained in proper order.

A building, such as that described in the paper referred to, has been erected jointly by the Barrow Hæmatite Steel Company, Limited, Messrs. Newton Chambers & Company, Limited, and the Wharncliffe Silkstone Colliery Company, Limited, in a central position conveniently situated for their respective collieries, which are in the immediate neighbourhood.

The trials made by Mr. W. E. Garforth in his experimental gallery at Altofts, with the Meyer helmet-apparatus, have clearly shown that men wearing that apparatus can climb over falls in a noxious atmosphere; but, owing to the comparatively short time during which they have been able to remain in the gallery, it was evident that an improved apparatus was needed before pneumatophores could be relied upon with confidence for either exploration or rescue-work underground in cases of real necessity. This was the feeling generally expressed by those who have had experience with them, and there is no doubt that the work accomplished has demonstrated weak points in the apparatus and

* *Trans. Inst. M.E.*, 1901, vol. xxi., page 100.

indicated the direction in which improvement was required. The discomfort of having the head enclosed in a helmet, the difficulty of both hearing and seeing, and the heat, and resulting headache, due most probably to the continual presence of an abnormal percentage of carbon dioxide immediately in front of the face, have been among the causes of this inability to wear the apparatus for a sufficiently satisfactory length of time. Another cause more recently discovered and remedied will be referred to later.

On the occasion of the visit of members of this Institute to the Düsseldorf Exhibition and the Westphalian coal-field in September, 1902, Mr. Meyer gave a demonstration at Shamrock colliery, Herne, with an improved apparatus known as the Giersberg pneumatophore,* a combination of the inventions of Dr. Giersberg and Chevalier von Walcher, and containing several features which make it decidedly superior to any apparatus tried in this country previously. It should be stated here that Mr. Meyer has abandoned the use of the helmet and that the apparatus was used with an indiarubber mouthpiece for breathing and a nose-clip.

The improvements referred to comprize:—(1) The substitution of solid alkali for the liquid formerly employed: consequently there is now no liability of any liquid getting up into e breathing-tube and causing burning in the mouth. (2) By ans of a regulating-valve, the admission of oxygen is adjusted the actual requirements of the wearer, and needs no attention further adjustment or anxiety on his part. This valve allows itres (122 cubic inches) of oxygen to pass per minute; the rer is constantly supplied with this amount, he cannot get ler more or less, and he is provided with a 2 hours' supply if cylinders are properly charged. (3) A relief escape-valve is ched to the breathing-bag, so that when there is any accumuon of gas the wearer can get rid of it by a slight compression he bag with his hand. This arrangement has been found to materially to the comfort of the wearer, and has done away one cause of the headache which was so often experienced. On the completion of the building referred to, it was decided obtain five complete sets of this improved apparatus, five considered to be the number of persons which should form

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 624.

one properly-constituted rescue-party. Some account of this apparatus and the experience gained in the attempt to train men in its use will probably be of interest to the members.

The following are the particulars and cost of the equipment as ordered in the first instance:—

	£	s.	d.
5 pneumatophores: Giersberg 1901 model, two-cylinder type, arranged with mouthpieces for breathing, at £12 10s. each	62	10	0
5 sets of spare cylinders for the above, at £2	10	0	0
1 complete filling apparatus, consisting of large oxygen-cylinder of 5,000 litres (17·6 cubic feet) capacity, hydraulic force-pump, tripod, connecting pipes and pressure-gauge	20	0	0
5,000 litres of oxygen, at 6s. per 1,000 litres	1	10	0
5 sets of cooling apparatus, at £1 each	5	0	0
6 indiarubber breathing tubes, with mouthpieces, at 2s. each	0	12	0
5 nose-clips, at 2s. each	0	10	0
15 tins of alkali, at 3s. each	2	5	0
3 tins of kieselguhr, at 1s. each	0	5	0
Carriage	1	18	9
Total	£114	10	9

It has since been found desirable to obtain three additional large cylinders for oxygen, and a supply of indiarubber breathing-tubes with mouthpieces of an improved type, and a number of portable electric hand-lamps; and these, with various fittings and tools, have brought up the total cost of the apparatus to about £175. This, however, can only be considered as an instalment and not as a complete equipment, which should consist of at least double the number of apparatus. The station being somewhat in the nature of an experiment, it was decided to limit the apparatus in the first instance to the number mentioned until further expenditure was justified by experience.

A retired army-sergeant was engaged as caretaker and instructor, and by the kindness of Mr. Meyer, he was thoroughly instructed at Shamrock colliery in the use of the apparatus.

The first attempt to wear the apparatus at the station was a failure, owing to the tendency of the breathing-tube to buckle: this so interfered with the freedom of breathing that the apparatus could only be kept on for a very short time, even by a man who subsequently showed himself capable of wearing it for a couple of hours with perfect ease. When the cause of this difficulty was discovered it was easily remedied, and with

the improved type of breathing-tube now in use the trouble cannot occur again.

During the last twelve months, practices in wearing the apparatus at the station have been held with fair regularity every week. The apparatus has been worn in the practice-room by about 50 men, and the results obtained may be roughly summarized as under, namely:—Ten men or 20 per cent. have been able to wear the apparatus for periods approaching to 2 hours; these men have taken part in the underground practices. And 10 men or 20 per cent. for shorter periods; these will probably improve with practice. Of the rest, some have been found unsuitable, and others have not persevered beyond wearing the apparatus for short periods of about 15 or 20 minutes. These results agree fairly well with the experience obtained at Shamrock colliery, where it has been found that out of 100 men tried, approximately 20 per cent. are found to be suitable and to make good men for the purpose, and about 35 per cent. are found to be constitutionally unsuitable.

One evening in the week has been set apart for each of the three subscribing collieries. As the apparatus requires to be washed out after each practice, and the cylinders have to be recharged, it has not been found possible to arrange for more than three practices per week. Four or five men have been present at one time, and those found suitable have been encouraged to attend until they have become capable of wearing the apparatus for about 1½ hours, or in some instances for a longer time. On the first attempt, men usually can only keep the apparatus on for 10 to 15 minutes. Some never get beyond this, being constitutionally unsuitable, and after about the third attempt continued perseverance on their part is useless, however willing they may be, or anxious to succeed. Usually men who are found suitable can extend the time to ½ hour on the second occasion, if they will adhere to the instructions given, and can afterwards do light work such as wheeling heavy stones in a barrow if they will take it steadily and not hurry—any attempt to rush about will quickly result in failure, as has been clearly proved on more than one occasion. In several cases, the apparatus was worn for 1 hour at the first attempt, and in one instance for 2 hours at the second attempt, without any discomfort or after ill-effects. In all cases, after the

apparatus has been worn for about 15 minutes, a slight tightness in breathing is felt; if the wearer keeps quiet for a minute or two this feeling passes away; and, afterwards, he seems to have got warmed up to the work, breathes with greater ease, and the uncomfortable feeling does not return.

It must not, however, be generally expected that men will be able to accustom themselves to breathing in this artificial manner without some inconvenience; but with men who are constitutionally suitable the liability to headache with the more recent type of apparatus has been, it is now believed, almost eliminated. If any discomfort or difficulty is experienced, relief can be immediately obtained by removing the nose-clip so long as the practice is being conducted in an ordinary atmosphere. In the smoke-chamber at Shamrock colliery, men are required to practice until they are able to wear the apparatus for 2 hours, and during this time perform an amount of work equal to about 20,000 foot-pounds. A wheel-and-axle arrangement is employed by which a weight is raised, and in this way the work can be measured. The practices are carried out with military discipline, to which German officials and workmen are accustomed. In the joint station under consideration, the training so far has been voluntary, and the men have come some distance to the practices. The only work attempted at the station has been the wheeling of heavy stones in the practice-room, and it has not yet been found convenient or advisable to follow out all the rules suggested by the writer in his former paper on this subject.

By the kindness of Mr. W. E. Garforth, an opportunity was afforded of testing the Giersberg apparatus in his experimental gallery in a noxious atmosphere. Two men remained in the gallery for a considerable time without any discomfort or after ill-effects, excepting a smarting of the eyes due to the smoke, and this could have been avoided by the use of goggles. One man remained in the gallery for about 1 hour and only came out when requested. He expressed himself confident of his ability to have remained for the full 2 hours; but, this being the first attempt, it was thought sufficient, the object being to demonstrate and obtain confidence in the practical utility of the apparatus. This test has clearly shown that the apparatus is reliable.

It was then considered desirable to have some trials conducted underground, so as to show what could be done in the way of travelling in the roadways of a mine. On the occasion of the first trials underground, an old roadway containing a fall of roof and several slight obstacles, the length being rather over 300 feet, and also a somewhat longer distance in a slightly inclined roadway, were selected for the purpose, both being ventilated by return-air and fairly warm. Three men wearing the apparatus carried a stretcher to the distances stated, and there placed a man on it and carried him back to the starting-point. The roadway over the fall was fairly low, and the stones were slippery. This was successfully accomplished in about 15 minutes, but the work was arduous, due to the weight carried and the lowness of the roadway in places, and in the second case to the weight having to be carried up a slight incline, and also to the fact that none of the men had previously attempted to wear the apparatus and walk with it in a pit. It was, however, thought desirable to make the trial fairly analogous to what might be expected in a case of real necessity. These trials were repeated several times, and clearly showed the desirability of having underground practices to accustom the men to travel the roadways wearing the apparatus, before expecting work to be done, which in the ordinary way, without any artificial breathing apparatus, would be by no means easy.

In a subsequent underground practice, two sets of three men proceeded from the pit-bottom up an inclined drift of 1 in 5, for a distance of 270 feet, and along a level roadway, 810 feet, into a working-place and returned to the pit-bottom, in 19 minutes, the roadway at the far end being only 3½ feet in height. This work was accomplished quite easily, the men not being exhausted, and stating that they could have gone further or made a second journey. In a more recent practice, three men, carrying brattice-cloth, proceeded up this drift, climbing over some corves, which had been overturned in the road and fetched a pony from a point, 405 feet from the top of the incline, nailed up two sheets across the road, and returned to the starting-point, having to move several corves out of the way to enable the pony to pass: the time occupied being 19 minutes. One of these men returned with two others; they took down the sheets, carried the brattice-cloth back, and moved corves out of their way as

before: the time occupied being 14 minutes. This trial was arranged to see whether work of this sort, which involved concerted action, could be done. The whole was easily accomplished, without any difficulty or unusual effort. No headaches have resulted from the underground practices.

Within the last eighteen months, Mr. Meyer has been using a modified apparatus, which he considers has now reached comparative perfection and to be a decided improvement on the pattern seen by the members on the occasion of their visit to Shamrock colliery. (1) In this type, there are three small oxygen-cylinders of reduced length instead of two. For convenience in travelling, it has been found desirable to keep the width of the apparatus within certain limits. It is also enclosed in a leather cover, and the weight is slightly greater. The oxygen is admitted into a ball-shaped enlargement of the breathing-tube; and the expired air passes into this enlargement through a contracted inlet on the principle of the injector. It was found from a number of analyses that the vitiated air did not get away from the breathing-tube with sufficient rapidity to avoid its being reinhaled, and that the oxygen was not sufficiently well mixed with it. Subsequent analyses have shown that the exhaled air is oxygenated very much more perfectly with the new arrangement, and the men wearing the apparatus are subjected to much less inconvenience, thus the tendency to headache is still further reduced. (2) The solid alkali is now introduced in the form of peas in gauze-holders, about 1 square inch in section; this provides a greater surface of alkali to act on the vitiated air, than in the older type in which the alkali is used in the form of sticks. The carbon dioxide is absorbed in consequence much more completely. (3) As an alternative to the nose-clip, the nostrils are fitted with plugs of cottonwool and lanoline, and a light leather cover or mask is worn over the nose. The writer is inclined to think that this arrangement is an additional discomfort, and has not found that the nose-clip have been objected to; this point, however, may be considered a matter of secondary importance. (4) A light cooling-tube has been introduced, through which the revivified air is caused to circulate.

In order to meet the preference for a mask, instead of the

mouth-breathing tube which has been found to exist in some cases, the makers have recently devised a mask-arrangement fitted with separate tubes for inhaling and expiration, and in which the volumetric capacity is reduced to a minimum: this is said to be giving satisfactory results, but the writer has not yet seen it. In Germany, the fire brigades have a preference for the mask, but collieries have chiefly used the mouth-breathing tube, although in some cases the mask is being adopted for collieries, and the makers say that opinion on this point is very much divided. The inability to speak seems to be the only real objection which can be raised to the mouth-breathing arrangement.

The weight of the two-cylinder apparatus, with the breathing bag complete, amounts to 28 pounds 6 ounces. The most recent type with three cylinders is slightly heavier, the total weight to be carried amounting to 33 pounds 11 ounces.

In the period under consideration, the chief items of cost in working the station have been about £15 for oxygen, including carriage of cylinders, £6 for alkali, and £4 for ordinary stores. The alkali is a special preparation, which is at present expensive in this country, as it is only obtainable from Berlin. About 6 pounds has been used on the average per week. The oxygen is compressed to a pressure of 120 atmospheres per square inch, and the apparatus must be charged to this pressure. The ordinary German cylinders of 5,000 litres capacity, however, do not conform to the British standard; and consequently the cylinders can only be charged in this country up to 80 atmospheres, which although sufficient for practices in the first instance, does not give a supply for the intended limit of 2 hours. For charging the apparatus, the storage-cylinders are fitted with connections at each end, by means of a force-pump water is introduced, and the oxygen is forced into the apparatus to the required pressure of 120 atmospheres by displacement with water.

The writer thinks that the experience gained points to the necessity for combined or joint action by several collieries, or an instalment on a sufficiently large scale to ensure that all the apparatus is maintained in perfect condition, and that there shall always be a man at hand who is thoroughly con-

versant with every detail of the apparatus and its use. It has been suggested that in addition to the instalment at the station, extra apparatus might be kept at the various pits; but there is great probability that they would be only examined occasionally, and this does not meet the case. The alkali must be introduced into the breathing-bag shortly before the apparatus is intended to be used, and a thorough knowledge and experience of the details of the whole apparatus is necessary on the part of the operator: without this, nothing should be attempted. The writer is therefore of opinion that all pneumatophores should be kept at the station, where they can be systematically overhauled and used in rotation for practice-purposes. Such a station should be within easy reach of any of the places which it is intended to serve.

It is essential that an adequate supply of portable electric lamps should be always available, and these lamps must be kept charged and used occasionally; these may well be kept at the various pits, where they will be found extremely useful by the officials. If not kept in working order and regularly charged, they will become absolutely useless from corrosion, and not available if required in an emergency. A breathing apparatus can be got ready for use in a few minutes, if the cylinders are kept fully charged with oxygen, but a portable electric hand-lamp of suitable size cannot be charged in less than 6 or 8 hours.

For use with the pneumatophore, the writer has had a lamp specially made, to give as much light as possible consistent with a reasonable weight and bulk. The lamp consists of a small liquid-accumulator battery in ebonite, enclosed in an aluminium case, $3\frac{1}{4}$ inches by $3\frac{1}{2}$ inches by $5\frac{3}{4}$ inches, a bulb fitted with two filaments, an electro-plated reflector covered by a strong glass or bull's eye, and locked with a leaden rivet. The lamp is carried by a leather hand-strap, and weighs $5\frac{3}{4}$ pounds. The accumulator, being nearly filled with dilute sulphuric acid (8 parts to 1 part) is charged from a 100 volts continuous current taking 1 ampère. The charging occupies 8 hours, and the lamp will give a light of 3 candlepower for about 6 hours. If the lamp is in good order, the light given is maintained for some hours without perceptible diminution. The cost of these lamps is £1 15s. each.

No difficulty has been found in getting suitable men to wear the apparatus and to practice until they can wear it a reasonable time, and the writer takes this opportunity of expressing his appreciation of the interest that the men have shown in the matter. The work done so far, however, can only be considered as preliminary, as a party capable of attempting serious work underground in an emergency cannot be formed until a sufficient number of men have had experience, not only in travelling in underground roadways and doing light work wearing the apparatus, but they must also have absolute personal confidence in the reliability of the apparatus in a noxious atmosphere, which latter can only be obtained with a smoke-chamber or a gallery such as Mr. W. E. Garforth's gallery at Altofts colliery. Unless the work is pushed on through this further stage, there is a danger that the interest will be found to flag, and it is at this point that encouragement is needed.

Sufficient experience has now been obtained with the apparatus to indicate that the object in view can be attained with perseverance. The progress made will be gradual, as the training must be thorough and complete; the nature of the work does not admit of its being partially or only half done, and it is necessary that the interest easily raised should be constantly maintained. The writer thinks that the result will be worth the trouble and slight expense involved, but would like to point out in conclusion that men who may be trained in connection with any station cannot be considered as available elsewhere.

Mr. G. Blake Walker wrote that Mr. Bernhard Dräger of Lübeck had written an interesting paper on the improvements that he had made in the pneumatophore, with the view of affording a sufficient supply of air to persons doing really hard work.* Mr. Habershon had pointed out the difficulties which he had experienced in his own experiments with the use of the pneumatophore, even in its most improved form, when really laborious work had to be done. Mr. Dräger had carried out a series of experiments with a spirometer constructed like a gasometer,

* *Glückauf*, 1904, vol. xl., page 1331.

and provided with a dipping bell and a large pipe fitted with a mask which covered the nose and mouth of the person experimented upon (Fig. 1). The bell is carefully balanced, and when the person puts on the mask the whole of the air exhaled is conveyed to the spirometer through the tube and the bell is lifted a corresponding distance at each respiration. The quantity of exhaled air can be read on a scale attached to the bell, and the spirometer can be put out of action by means of a tap. Mr. Dräger conducted experiments upon three men weighing 175 pounds, 143 pounds and 122 pounds respectively. The following are the results of these experiments:—

FIG. 1.—THE SPIROMETER.

No. of Persons tested	I.	II.	III.
Height	70·7 inches	65·5 inches	65·2 inches
Weight	175 pounds	143 pounds	122 pounds
	Volume of air respired by each person in one minute, after each use of the apparatus.		
Description of Work:	Cubic Inches.	Cubic Inches.	Cubic Inches
Sitting still and doing nothing for 10 minutes	519	503	549
Walking a distance of 820 feet	641	690	714
Do. do. 1,640 feet	873	1,068	793
Running a distance of 820 feet	1,831	1,831	1,831
Do. do. 1,640 feet	2,319	2,563	2,319
Two men together in stooping attitude dragging a man	1,831	—	—
Rolling casks weighing 168 pounds	2,319	2,014	2,472
Racing a distance of 820 feet	3,173	3,722	3,600
Time	40 seconds	42 seconds	42 seconds

The ordinary pneumatophore contains only about 366 cub inches (6 litres) of air: obviously, therefore, a man doing ha

work requires a great deal more air than the pneumatophore contains. Therefore, for 3,660 cubic inches (60 litres) the same small quantity of air would have to circulate ten times a minute through the apparatus. Mr. Dräger thinks that the apparatus ought to be able to deliver 2,440 to 3,050 cubic inches (40 to 50 litres) of pure air per minute. He has accomplished this by one or two modifications of the apparatus. To remove any possibility of the exhaled air being breathed in again before it is purified, he divides the breathing-bag into two parts. One portion receives the exhaled air, and the other is used as the reservoir for the purified air. It is of the utmost importance that the person using the pneumatophore should breathe only air which is really pure, that is to say, which contains much less than 1 per cent. of carbonic acid. The more carbonic acid the air contains the quicker and deeper is the breath. At present, the supply of oxygen from the cylinders to the breathing-bag is a constant quantity, regulated with the idea of an average consumption, but obviously some regulation is required, seeing how much more air is necessary when hard work is being done, than when the man is resting or doing light work. Mr. Dräger's second modification is based on a suggestion of Mr. Meyer to have two oxygen-supplies, one being sufficient for moderate

FIG. 2.—FRONT VIEW OF THE DRÄGER PNEUMATOPHORE.

ertion, and the other which can be used as an addition al
pply when doing harder work.

Mr. Dräger's apparatus consists of oxygen-cylinders, wi th
supplying and circulating contrivances, alkali-cartridges to
absorb carbonic acid, and a smoke-helmet used as a face-ma k-
(Figs. 2 and 3). By using very wide and short pipes, by wide- ra -
ing all the connecti ra s
parts, by arrangi ra s
two cartridges pa a-
allel, and by mak i ra s
a better use of th e
oxygen, Mr. Drä s- r
has been successfu l i n
producing in the a l-
paratus a circula t i o n
of about 3,050 cu b ic
inches (50 litres), a n d
the apparatus deliv e rs
about 183,000 cu b ic
inches (3,000 litre s
of pure air per hou r.
To avoid the mixi ng
of the purified a i r
with the exhaled a i r
in the face-mask, th e
principle of havi ng
only one breathin g-
bag has been aba n-
doned, and two sep a-
rate bags are us e d.
In consequence
this arrangement,
becomes necessary

Fig. 3. Back View of the Dräger Pneumatophore.

provide on the helmet an inhaling-valve for the bag of pure air, a
an exhaling-valve for the bag of exhaled air. Mica-plate val e
have proved very suitable for this purpose. The bag on t
right-hand receives the purified air, and the bag on the le-
hand will absorb the exhaled air. The two bags of the appara
act like two regulators, out of which the circulating appara
can draw, or into which it can blow the air proportionately, a
ing intervening respirations (Fig. 4).

As most persons feel themselves much inconvenienced (especially when doing hard work) if breathing through the mouth and nose is restricted, Mr. Dräger prefers the mask to the clips and mouthpiece usually employed. He believes that no inconvenience is really due to the use of the helmet, and that the assertion of the miners that they suffer by the heat of the helmet is a mistake. He believes that the inconvenience which these men feel must be ascribed to the effect of the inhaled carbonic acid, and the experiments that he has made appear to bear this out.

To obtain reliable comparative results, Mr. Dräger selected those kinds of labour which required a rather large amount of exertion, as for instance:—Wheeling stones on moderate roads, running, carrying a person in a stooping position, ascending and descending a ladder, and so on. He made a series of tests which demonstrated that the apparatus successfully fulfilled all working requirements. Neither indisposition nor headaches were felt in any case. Mr. Dräger had wheeled stones for 11 hours, and was thus able to confirm the accuracy of the statements made by other workers. An experiment in wheeling stones on garden-roads for 2 hours, made by five persons at the same time, confirmed all previous observations. After having done this work, each man resumed his usual occupation without requiring any interval for recovery. Whether the experiments are performed in fresh air (Mr. Dräger made them during the hot days of July of this year) or in the smoke-chamber, has no important effect on the results, because the breathing organs are excluded from the outer atmospheric air. To prove the absolute tightness of the helmet, Mr. Dräger

Fig. 4.—The Dräger Air-bags.

allowed the persons who had been making the experiment t[illegible] enter a chamber filled with sulphurous-acid fumes and no il[illegible] effects were experienced.

It is of special interest to ascertain whether the alkal[illegible] cartridges, disposed in layers, are really capable of absorbin[illegible] the large quantities of carbonic acid exhaled from the lungs [illegible] performing work. It is unnecessary to measure the capaci[illegible] of the cartridges for absorbing carbonic acid if one ascertai[illegible] that they deliver pure air, without any carbonic acid, from t[illegible] beginning to the end of the working of the apparatus. Ther[illegible] fore one must take out of the right-hand breathing bag sm[illegible] samples, and ascertain whether they contain carbonic acid. T[illegible] following method may be employed for this purpose: By me[illegible] of a short pipe, a small sample of air is taken by a little gla[illegible] syringe out of the breathing-bag, which is supposed to cont[illegible] pure air. In the nozzle of this syringe is a long thin pipe wh[illegible] is immersed in a thin test-tube half filled with clear li[illegible] water. By pushing the piston of the syringe slowly down, t[illegible] breathing air, which is to be examined, bubbles through t[illegible] water. If carbonic acid is present in the air, even in very sm[illegible] quantity, the water becomes milky. In order to see the degre[illegible] of milkiness produced in lime-water by air which contains ca[illegible] bonic acid, one takes air, which has been once in the lungs, ou[illegible] of one's own mouth by the syringe, and the lime-water in th[illegible] test-tube becomes quite turbid. By means of this contrivanc[illegible] for examining the breathing air, Mr. Dräger was able to ascer[illegible] tain that the apparatus still delivered air free from carboni[illegible] acid after 2 hours' working. Further, he had found out tha[illegible] the weight of two cartridges in an apparatus, used in the before[illegible] mentioned experiment, had together increased by 8·8 ounces[illegible] (250 grammes). By treating the contents of these two cartridges[illegible] with sulphuric acid, 5,736 cubic inches (94 litres) of carbonic[illegible] acid were extracted, which was exactly indicated by the spiro[illegible] meter. Therefore it may be believed that a man produced in working about 2,868 cubic inches (47 litres) of carbonic acid per hour.

In confirmatory experiments it was found that (1) the gas obtained in the spirometer had, with the exception of a very small quantity, been absorbed by shaking in lime-water, by which it was demonstrated that it really consisted of carbonic

acid; and (2) the contents of a cartridge, which had not been used before, when treated with sulphuric acid, only produced vapour, which condensed at once, and had no influence on the spirometer.

The production of carbonic acid by a person and the work performed by him are evidently in direct proportion to each other; and in following out this idea Mr. Dräger was pleased to discover a measure for estimating the exertion of the persons tested by the increase in the weight of the alkali-cartridge.

When 122 to 128 cubic inches (2 to 2·1 litres) of oxygen were delivered in one minute, Mr. Dräger could not observe that the breathing-bag shrivelled. When the oxygen-cylinders were pumped up to a pressure of 125 atmospheres, in which case the twin-cylinders contained about 15,000 cubic inches (250 litres) of oxygen, the apparatus contained a quantity of air sufficient for exactly 2 hours; and from the beforementioned experiment it had been plainly demonstrated that this proportion was correct.

Mr. C. Chetwynd Ellison asked whether there was still a difficulty in obtaining sufficiently pure oxygen for charging the cylinders. He thought that the increase in the number of cylinders was a great improvement, but he noticed that there was an increase in weight of nearly 20 per cent., and this was a serious item when a man had already to carry over 28 pounds. He would like to know the cost of working a rescue-station, together with the cost of each man's practice, including the man's pay, as a man could not be expected to undertake this kind of work without being adequately remunerated. During the little time that he had used the helmet, he preferred it to the mouth-piece and nose-clip. The effect of stopping the breathing through the nose did not affect all persons to the same extent, and to some people it caused considerable unpleasantness; he also thought that, for many reasons, the helmet was preferable on account of the mouth being free. One of the objections to the use of the old helmet arose from the moisture of the breath which dimmed the glass-window of the helmet, and if the moisture were absorbed, it would effect a very great improvement. He desired to emphasize the point that owners, who had trained their men, must not be expected to allow themselves to be "sponged upon" (an expression of that sort was

the only way of describing what he meant) by other owner who were going to sit on the fence and do nothing at all. H might be wrong, but, personally, he hoped that the Gover ment would take up the question: every colliery-owner shou be made to do something in this matter, in the same way every owner had to keep an ambulance at his colliery. agreed with Mr. Habershon that it would be a foolish idea any one to start these practices, unless they intended to ca them out most thoroughly, as the apparatus was danger when used by inexperienced persons.

Mr. W. H. PICKERING, in proposing a vote of thanks to Habershon for his paper, said that the question had intere him ever since he came to the district. He thought that it most important that the Institute should organize rescue-stat i throughout the district, and, as Mr. Habershon pointed out his paper, it would not be reasonable for any one station, in t case of a disaster, to be called upon to send apparatus and wor men to another colliery, as they would no doubt feel bou to respond.

Mr. W. E. GARFORTH, in seconding the resolution, co gratulated Mr. Habershon, and the three companies concerne on the good work that they had done during the past year. Th had in some respects improved upon the experiments made Messrs. Pope & Pearson's collieries, which some of those prese would remember seeing some two or three years ago. He co sidered that the improvements made by Mr. Dräger were mo valuable, and he believed that the apparatus was still capab of further improvements. Since the Altofts experiments, had the impression that the apparatus was not sensitive enoug that it should be made by a surgical instrument-maker, a that the position and weight of the various parts could be bett distributed by having them stitched or sewn in the workmen special coat. In this way, the efforts of the intended explor would be greatly facilitated, and the exploration-work would far less exhausting. In the Astley explosion, where 62 m were killed, and in the recent fire at the New Moss colliery, t latest design of life-saving apparatus would have been m valuable. He believed, if the experimental work was continu that it would lead to the apparatus being gradually impro

In its present condition, so many imperfections existed that he certainly could not recommend it to be used for any work in a highly noxious atmosphere, requiring more than 1 hour's time from the pit-bottom, or in case of much exertion for more than ½ hour, and then only when used by properly trained men. He sincerely hoped that the members of the Institute would continue to maintain their interest in all inventions having for their object the saving of life.

Mr. M. H. Habershon, replying to the discussion, said that he had found no difficulty in getting oxygen sufficiently pure for the purpose of the pneumatophore. The apparatus, at first sight, appeared to be rather heavy, but troops on the march carried a greater weight and for a longer period, and he did not think that too much ought to be made of that point. It had been found that it was not easy to perform hard work when wearing the apparatus in the low roadways of a mine, but there might be many occasions when it could be very usefully employed, if only for exploration, or light work. If only this could be accomplished at first, development would take place and they would probably obtain better results; but if they did nothing at all, they would still remain in the present unsatisfactory position. The new apparatus, on view before the members, as far as he was aware, was the only one in the country; and the old pneumatophore, which members might have bought some years ago, he believed, would prove useless and cause headache. There was no liability to headache with the newest type, and the analyses which had been made of the air in the breathing-bag were satisfactory. If men attempted to perform hard work, difficulties would be experienced; but a man could climb over a fall, carry a light article, fix up brattice-sheets, move corves, or even carry a man for a short distance. It became hard work, however, if a man was placed on a stretcher, and such a heavy weight was carried along a roadway only 3½ feet high; and he did not think that it was reasonable to attempt such hard work without further practice and experience with the apparatus.

DISCUSSION OF MR. W. H. PICKERING'S "NOTES ON SYSTEMATIC TIMBERING."*

Mr. W. H. PICKERING said that the model code of rules suggested in his paper,† embraced rules mostly in force at some colliery or another. The quantity of timber used was only a question of the first supply; and if a really good system was adopted and the props were fixed sufficiently close, most of the timber could be recovered and used again, particularly if substantial lids were used. A point which had not been mentioned in the discussion, and which he had had some diffidence in bringing forward, was that of supervision. He should like all the members to consider whether they had sufficient supervision as regards timbering. A good pitman and a member had told him that he had doubled the number of deputies and had thereby reduced his costs.

Although the discussion on his paper was now closed, he hoped that the subject would not be forgotten, as it concerned not only safety, but also economy.

The annual dinner was subsequently held.

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* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 95; 1904, vol. xxvii., page C^2; and 1904, vol. xxviii., page 87.

† *Ibid.*, 1902, vol. xxiv., page 98.

NORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING.

HELD AT THE NORTH STAFFORD HOTEL, STOKE-UPON-TRENT, DECEMBER 5TH, 1904.

MR. W. N. ATKINSON, PAST-PRESIDENT, IN THE CHAIR.

The minutes of the last meeting were read and confirmed.

The following gentlemen, having been previously nominated, were elected:—

MEMBERS—

Mr. JOHN DAVIES, Manager, Hanley Borough Colliery.
Mr. W. G. PEASEGOOD, Manager, Leycett Collieries.

DISCUSSION OF MR. G. E. LAWTON'S PAPER ON "FIRES IN MINES, WITH PARTICULAR REFERENCE TO SEAMS IN THE NORTH STAFFORDSHIRE COAL-FIELD."*

Mr. G. E. LAWTON said his statement that "the activity with which oxygen is absorbed increases as the temperature rises"† had been conclusively proved by Dr. J. S. Haldane, who found by experiment that 1 ton of dust from coal which had been got 4 days previously, absorbed 2·4 cubic feet or 0·18 pound of oxygen per hour at a temperature of 59° Fahr. At a temperature of about 80° to 85° Fahr., the absorption would be nearly twice as rapid, that is, about 0·3 pound per hour.‡ Further, this conclusion was approved by the New South Wales Royal Commission§ in 1897, and in their report the causes of the spontaneous combustion of coal in ships were put forward simply, clearly and conclusively.

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 109.
† *Ibid.*, page 114. ‡ *Ibid.*, 1898, vol. xvi., page 474.
§ *Ibid.*, 1900, vol. xix., page 546.

With regard to "the probable generation of electric stresses in gob-heaps,"* it was recognized that electric energy was developed by steam issuing from safety-valves, etc., and an electric machine had been constructed by the late Lord Armstrong and charged by issuing steam at a pressure of 60 pounds per square inch. The pressure of gas escaping from coal ranged from a low point up to 400 pounds per square inch, and probably higher pressures had been recorded. He (Mr. Lawton) had registered pressures up to 200 pounds per square inch, in a bore-hole in a crut. If gas at these high pressures was liberated in a goaf, there might be a probability of small electric stresses being generated on a small scale.

He (Mr. Lawton) had stated that "thick seams, generally speaking, are more friable, and usually there is greater rock-pressure on the coal."† This opinion was only intended to apply to the seams of the North Staffordshire coal-field. At the collieries with which he was connected, at the present time, ten seams of coal, varying in thickness from 2 feet to 9 feet, were being worked, and the thick seams, at times, yielded a larger proportion of slack than the thin seams, tending to show that these thick seams were more friable than the thin seams; and he thought that this was largely due to the greater rock-pressure on the coal. However, as was well known, there were many thick seams which were not friable. The Ten-yards coal-seam, in South Staffordshire, at certain collieries, was not friable and there was not much rock-pressure on the coal; nevertheless, it was subject to gob-fires.

Mr. John Cadman remarked that "Mr. Lawton had mentioned pyrites, but he (Mr. Cadman) thought that pyrites played a much more important part than was generally supposed."‡ He (Mr. Lawton) had, however, stated that very considerable importance should be attached to the part played by pyrites under certain conditions.§ There appeared to be little doubt that some fires in the Bullhurst seam had been caused by the influence of pyrites, as shown by Dr. Haldane's experiment with a piece of coal from the Bullhurst seam. It appeared that when pyrites was distributed in a fine state of division in the

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 111.

† *Ibid.*, page 111. ‡ *Ibid.*, page 123. § *Ibid.*, page 112.

, fires might be initiated, but when it was found in bulk there ared to be little danger of fires.
He (Mr. Lawton) agreed with Mr. Cadman that moisture sometimes, the main factor in starting a fire.
He (Mr. Lawton) had been told by Mr. T. E. Storey that in gob-fires that had taken place in the Ragman seam at Leycett collieries, were probably produced by the shale, between the Ragman and the Rough Seven-feet coals.

Mr. EDWARD B. WAIN said that there were many points nted in Mr. Lawton's paper which invited the fullest discn and, naturally, that part of the paper which dealt with ires must first receive attention. In this connection he Wain) thought that perhaps too little attention had been in the past to the part which the pressure of the superinent strata played in promoting spontaneous combustion ines. He was glad to see that Mr. Lawton had called inent attention to this question, as he (Mr. Wain) was very gly of opinion that a very large proportion of the gob-fires in Midland districts were entirely due to this cause. In workome of the thicker seams, and especially when working on pillar-and-stall system, it frequently happened that small rs of coal were left in the goaves, and the enormous rockure to which these were exposed and the consequent fricl action did undoubtedly produce intense heat. He (Mr. n) remembered several cases of workings in the Cockshead -seam, where stalls were driven 60 to 75 feet wide, with rs 24 feet wide on each side of the jigs, and where the floor r the pillars often became so hot that it almost burnt the l. He had also noticed in the same pit that several small icts worked on the pillar-and-stall system were invariably er than longwall workings in the same pit and seam.
t was common knowledge that many gob-fires started near "opening-off rib;" when coals were worked on the longwall m and with main roads driven in the solid, this used to be frequent in some of the collieries in the Warwickshire coal-, and especially in the Seven-feet seam of the Tamworth ict. The particular coal-seam, in which the Warwickshire referred to did occur, contained a large proportion of

pyrites; but he thought that the pressure on the pillars was the most general cause of the fires.

Speaking generally, he thought that where coal-seams were worked on the longwall system with gob-roads throughout, there was much less liability to fire. He also was strongly of opinion that in seams, such as they had in North Staffordshire, lying at high inclinations, it was imperative that they should so arrange their workings as to have ascensional ventilation throughout. Apart from the general convenience of such a plan, any heat generated in the goaf found a natural outlet to the rise; and as, when stocking slack from seams particularly liable to spontaneous combustion, fires were often prevented by the simple expedient of fixing a wooden pipe to carry off any heat generated in the body of the heap, so too in underground workings if there were a proper means of escape for heat from the goaves or wastes, the cumulative action of the heat would be avoided, and the heat necessary for keeping up the action of the distillation would be removed in many cases. Let them take for example, a simple illustration of this in the case of a slack-heap heating on the surface: if the heat was noted at an early stage, the usual plan was to cut through it and let the heat escape; the exposure of the heated particles to the cooling action of the air reduced the temperature and the heating action due to oxidation ceased, notwithstanding the increased supply of oxygen. He (Mr. Wain) remembered a striking example, which he had previously brought before the members,* where an incipient gob-fire was dealt with in this manner under particularly awkward circumstances, and where the temperature was already high enough to show very active heating. As a further argument, he would remind the members that it was very unusual to hear of a gob-fire in a seam with a strong rock- or sandstone roof, whilst they were undoubtedly common in coal-seams with soft strata (such as fire-clay), easily disintegrated by atmospheric influences, lying immediately over the seam. This statement might be said not to be in accord with his previous remarks about roof-pressure, as undoubtedly the stronger roof would bring greater frictional pressure to bear on the coal, but being of a more porous nature and breaking into larger masses it would allow any heat evolved to pass away more readily than in the

* *Trans. Inst. M.E.*, 1893, vol. vi., page 575.

e of the more friable roof. Mr. Lawton stated that fires l occurred in the Seven-feet Banbury coal-seam, under a k-roof, and as this was the first record of a fire under such ditions with which he (Mr. Wain) had ever met, and as he ad no details in the paper regarding the fires in question, he ld be glad to know whether the particular section of the n given was a correct one for the exact point where the occurred.

Dealing generally with the question of the causes of gob- , it appeared to him (Mr. Wain) that practically the sole e was the presence of coal in a fine state of division ough in some of the seams of the North Staffordshire dis- a highly carbonaceous shale or "hustle" did, no doubt, uce similar results) and it was only by removing, if prac- ble, all pillars and accumulations of slack from the wastes the danger would be overcome. Of course, he could not ook the great difficulty which was presented where inferior ls of coal lay over workable seams; and these, even when y particle of coal or slack had been removed from the kable seam, would still present the same element of danger frictional action and ultimate disintegration. With coal- ls worked on a systematically arranged longwall plan, with asional ventilation, with packs carefully built, with waste- es at regular intervals to let off any excess of heat to the as it was evolved, and with all small slack cleared out of the es, the risks from gob-fires would be reduced to a minimum. Mr. Wain) knew that in some of the more highly-inclined ts on the western side of the North Staffordshire coal-field as almost impossible to comply with all these requirements, Perhaps some members, with wider experience in that part eir district, could, at least, suggest some points for deal- with the matter, and he thought that their time that day ld be better occupied if they discussed the question of the val of the cause of these serious hindrances to profitable ing, rather than consider the means of dealing with the fires n they had actually broken out. Each case of fire had to alt with in accordance with its own peculiar circumstances, the prevention of the fires was the wider and more serious blem.

The members were indebted to Mr. Lawton for the matter

in the latter part of his paper dealing with fires from other causes, and while the circumstances attending such fires would in almost every case vary, any record of difficulties overcome was always helpful.

The difficulty of securely sealing shafts when such drastic steps had to be taken had been noted by Mr. Lawton, and, in dealing some 23 years ago with one of the most disastrous pit-fires which had ever occurred in the district, he (Mr. Wain) had noted an instance that very well illustrated this point, and might prove of interest. The facts were as follows :—

As the result of a tremendous fire which, starting near the bottom of the downcast-shaft, travelled through 750 feet of rise-headings and up the upcast-pit, 1,005 feet deep, with such intensity as to burn down the screens, winding-engine house and other pit-head erections, and even to wreck the lower part of the shaft by burning out the oak and bricking curbs, and within a few hours of the start of the fire, it became necessary to fill up that shaft. After 180 feet in depth of the shaft had been filled with pit-mound débris, the temperature was still 88° Fahr., and it was not until 4 days had passed, when more than half of the depth of the upcast-shaft was filled, that the direction of the circulation of the air was reversed and gas began to be given off at the top of the downcast-shaft. The top of the downcast-shaft was then closed and arrangements were made later on to fix an escape-pipe for the gas, on which the upward pressure was tested daily by means of a water-gauge. This pressure steadily increased, until 4·17 pounds per square foot was noted; and it was then decided to puddle with clay the top of the upcast-shaft, which had already been filled up to the surface. As soon as the puddle was completed and flooded with water, the upward pressure of gas at the top of the downcast-shaft fell, at once, to 1 pound per square foot, and during the remainder of the time until the scaffold was removed, only shewed very small variations concurrently with fluctuations of the barometer. Table I. contained a record of the barometer-readings, gas-pressures, and temperatures, and would more fully illustrate his remarks; and he thought that it would tend to prove his theory that there was a distinct circulation of air through the vertical height of 1,005 feet of material filled into the upcast-shaft, before it was puddled and watered.

TABLE I.—RECORDS OF BAROMETER READINGS, VARIATIONS IN THE UPWARD PRESSURE OF THE GAS, ETC., AT THE TEST-PIPE ON THE DOWNCAST-SHAFT.

Dates.	Height of Barometer.	Pressure of Gas per Sq. Foot.	Temperatures.		Dates.	Height of Barometer.	Pressure of Gas per Sq. Foot.	Temperatures.	
			Surface.	Pit-bottom.				Surface.	Pit-bottom.
1881. Feby.	Inches.	Pounds.	Degs. Fahr.	Degs. Fahr.	1881. March	Inches.	Pounds.	Degs. Fahr.	Degs. Fahr.
24*	28·40	2·58	44	65	5†	28·80	2·75	43	64
25	28·00	3·06	45	66	6	28·80	1·08	51	64
26	29·07	2·80	45	64	7	28·57	1·39	52	63
27	29·20	2·69	43	63	8	29·06	1·39	45	62
28	29·20	3·24	42	64	9	29·17	1·39	49	63
					10	29·36	0·96	50	60
March					11	29·40	1·08	49	61
1	29·40	2·80	42	61	12	29·40	1·08	49	60
2	29·67	2·80	43	63	13	29·27	1·39	46	59
3	29·33	4·17	43	63	14	29·27	1·08	47	60
4	29·87	3·85	43	64	15‡	29·60	0·80	48	60

* Upcast-shaft filled up to the surface. † Top of upcast-shaft puddled and covered with water. ‡ Scaffold removed.

He (Mr. Wain) had already spoken of the part which frictional action played in the generation of heat, but he did not for a moment mean to imply that friction alone would develop sufficient heat to produce actual ignition. He wished, however, to convey that the crushing action reduced the coal to the state of fine division needed for the ready absorption of oxygen, and that the heat arising from friction gave such an increase in temperature as would accelerate the action of oxidation. He had read the valuable paper recently given to The Institution of Mining Engineers on the "Problems of Gob-fires" by Mr. George Farmer, who was on this point entirely in accord with the views he had just expressed. In fact, Mr. Farmer had followed the same lines as himself (Mr. Wain), but had dealt with the matter in a fuller and more lucid manner; and he had found such similarity in the views expressed that he had been tempted to destroy his own notes and content himself with a bare reference to Mr. Farmer's paper.

He could not refrain from quoting the following extract from Mr. Farmer's paper in which that writer, speaking of the part played by mechanical energy, said that "mechanical energy is convertible into heat, and heat may be converted into the potential energy of chemical separation; again, the energy of chemical separation is again convertible into heat."* It seemed impossible to condense the whole theory of the matter into fewer, or better chosen words.

* *Trans. Inst. M.E.*, 1904, vol. xxviii., page .

He (Mr. Wain) would like to say a few words on the danger which arose from lucifer-matches being thrown down or hidden by men who had thoughtlessly taken them into the pit. He (Mr. Wain) had in his possession a number of matches or match-boxes which had within a short period been found lying about underground. It was, of course, useless to attempt to detect or punish the persons responsible for placing them there, but it certainly was a source of real danger, as there might be many cases of matches being taken into the pit and thrown or hidden in the wastes, where, in dusty or fiery mines, they would cause serious trouble or fire as suggested by Mr. Cadman.* It was difficult to suggest a remedy, but certainly workmen should be searched from time to time, so as especially to warn them to use greater care; and, without wishing to deal lightly with what was a serious breach of the rules, he thought that, where a man found that he had inadvertently taken matches into the pit and promptly and voluntarily gave them up to an underground official, a somewhat lenient view of the case might be taken, so that there would be less temptation to dispose of them in some irregular way which would prove a source of danger to the mine.

Mr. W. L. Hobbs drew the attention of the members to the evidence given by Mr. R. Threlfall before the Royal Commission on Coal-supplies.† He (Mr. Threlfall) had been the president of a Royal Commission appointed by the government of New South Wales in 1896, to enquire into the cause of the large number of cases of spontaneous combustion in ship cargoes of coal from New South Wales.‡ Experiments were made with two bins, each containing 245 tons of coal, one wet and one dry. The dry coal heated from 40° Cent. to 200° Cent., when it was just on the point of firing; and the temperature of the wet bin rose from 30° Cent. (the effect of the damping having been to cool it 10° Cent.) to 47° Cent. only.

The coal was a very fine unscreened gas-coal. These experiments appeared to settle conclusively the point that dry coal was more dangerous than wet. In 1876, there was a British Commission on the same subject, and of 27 witnesses, 26 were

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 124.

† *Second Report of the Royal Commission on Coal-supplies*, 1904, [Cd. 1971], vol. ii., page 227.

‡ *Trans. Inst. M.E.*, 1900, vol. xix., page 546.

of opinion that wet coal was the more dangerous. On investigation it turned out that their opinion was from hearsay only, and there was really no evidence to support the opinion. Mr. Threlfall thought that it was an old prejudice arising from the idea that spontaneous combustion of coal was similar to that of new hay—a process of fermentation. The scientific advisers (Profs. Abel and D. Percy) of the Royal Commission originally thought that the dry coal was the more dangerous, but they came to the conclusion that wet coal was the more dangerous.

The Board of Trade had asked Mr. Threlfall to hold an enquiry, in 1900, into the subject, with the result that, although previously they had compelled wet cargoes to be discharged, they no longer took that action.

He (Mr. Hobbs) said it appeared to be the general opinion that the decomposition of pyrites did not produce spontaneous combustion, as the chemical action only gave out heat in small quantities. The proportion of pyrites in a coal-seam, luckily, was not very great, about 1 per cent. of sulphur being probably near the average. The real cause appeared to be more probably connected with the oxidation of fine coal; but the question as to whether the presence of moisture was detrimental or otherwise to the absorption of oxygen was very interesting.

Mr. George H. Greatbatch said that he had worked the same seam at two collieries, one being absolutely dry and the other moist, and there had been no gob-fires in the dry seam but fires had occurred in the moist seam. In some old workings, 150 feet below a main level that had been abandoned for a few years, no heat was given off before a dam broke down and the water ran into the goaf; a fire then resulted, and it was built off. At the present time, when thirling into a line of old moist drifts, high temperatures were always obtained. Another fire occurred where there was practically no roof-pressure. Some levels were being driven in the Cannel Row coal-seam, the overlying seams not having been got, the roof required little timber, and the dirt, lying under the coal, was filled into the thirlings between the level and the deep head. The coal in the deep head was discovered to be on fire at the corner of the thirling against the brick-stopping, the thirling was unloaded, and the fire was then put out by water. An examination was made of the other thirlings which had not been

filled for more than 6 months, and signs of heating were found all the thirlings were then unloaded. An experimental longwall drift was started from the levels, temperatures of 85° to 90° Fahr. being found in the wastes and in the return-airways, the packs were all buried as quickly as possible, and no fire took place. He (Mr. Greatbatch) maintained that gob-stink could be produced without roof-pressure.

Mr. W. N. Atkinson (H.M. Inspector of Mines) observed that the theories as to the cause of spontaneous combustion in mines were not based on complete and accurately defined scientific reasons, and the liability of any particular seam to fire spontaneously could only be discovered by experience. The reasons why the same seam took fire in some pits and not in others were not fully understood, and further research in the subject was required. Fires in mines were a source of the greatest danger, and too much could not be known about their causes and the best methods of dealing with them. He had recently read a pamphlet by two Russian engineers, in which they pointed out that little advance had been made for centuries in the methods of combating underground fires. They advocated the establishment of an elaborate system of dams which could be speedily closed so as to isolate any section of a mine in which a fire occurred, and they had devised a method of closing these dams by electricity.* In seams well known to be liable to spontaneous combustion, the system of working the mine in separate panels with pre-established dams was frequently carried out, so that any section could be isolated by the closing of two dams. Mr. Lawton had referred to the necessity of building strong dams where there was risk of an explosion in the part built off, and this was an important point. The Hartcastle Moss pits were lost in October, 1894, by an explosion caused by a gob-fire, which blew out two brick-stoppings, 9 inches thick, within 24 hours after the stoppings were completed. He thought that 20 or 30 feet of good solid stowing would probably be sufficient to resist the force of any mine-explosion in roads of average dimensions.

Mr. G. J. Crosbie-Dawson wrote that he agreed with Mr. Cadman in his opinion of the chemical source of heat, and

* *Nouveau Système pour combattre les Incendies dans les Mines*, 1904, Messrs. J. Krzyzanowski and St. Wysocki.

thinking that pyrites plays a much more important part than is generally supposed. Pyrites is known to oxidize, sulphuric acid would then be produced, and on the addition of water, this would produce a considerable amount of heat. In making the new railway between Leek and Waterhouses, the earthwork in the cuttings was in excess of that required in the embankments, and, consequently, the contractors were compelled to tip the surplus material to spoil. One of the cuttings, near Waterhouses, was through Yoredale Grit and Black Shale, and the excess material from this cutting was tipped to spoil on adjoining land with the result that the heap was ignited by spontaneous combustion. This was, no doubt, brought about by the grinding and slipping movements and frictional action of tipping mass upon mass of this material: all went well until rain came, when, doubtless, chemical action engendered sulphuric acid and hastened the catastrophe. These remarks demonstrate that civil engineers as well as mining engineers have to battle against "gob-fires."

Mr. G. E. Lawton, replying to the discussion, said he agreed with Mr. Wain that workings on the pillar-and-stall system were invariably hotter than workings on the longwall method; and possibly this difference might be accounted for largely by the fact that usually there was not so strong a ventilating current under the pillar-and-stall system of working as under the longwall system. He also agreed with Mr. Wain that ascensional ventilation in highly inclined seams was the correct method; but one must not lose sight of the fact, that to prevent gob-fires in gassy mines, the goaves must be charged with fire-damp, and if ascensional ventilation was carried too far this object might be defeated.

The section of the Bullhurst seam was taken in the neighbourhood of one of the fires. Several fires had occurred in the Seven-feet Banbury coal-seam, under a rock-roof, and, at the present time, he (Mr. Lawton) was opening out a district in this seam, where rock of great thickness lay immediately upon the coal. No doubt, the most serious problem was the prevention of fires, but after coal had been worked by the most approved method and every precaution taken, fires might still occur.

The Ten-yards coal-seam of South Staffordshire and the Bullhurst seam of North Staffordshire contained pyrites of a poor character, and, as is wellknown, both of these seams were highly subject to fires. On the other hand, thick bands of pyrites were left underground in some seams in which fires had not been known to occur. In working the Maudlin seam in the county of Durham, the thick bands of pyrites were left underground in exactly the same way as dirt-bands were left underground, and he had not heard that any fires had been caused by spontaneous combustion in that seam.

He agreed with Mr. Greatbatch's remarks that gob-stink could be produced without roof-pressure, and this was demonstrated by the fact that numerous old pit-heaps had taken fire by spontaneous combustion.

He agreed with Mr. John Cadman and Mr. E. B. Wain as to the probability of fires being caused by matches taken into the mine by workmen. He had had similar experiences of matches having been found in the mine, and he thought that Mr. Wain's suggestion that the workmen should be searched from time to time, to prevent, as far as possible, a recurrence of these incidents, was a good one.

THE MIDLAND COUNTIES INSTITUTION OF ENGINEERS.

GENERAL MEETING,
HELD AT UNIVERSITY COLLEGE, NOTTINGHAM, DECEMBER 17TH, 1904.

MR. W. B. M. JACKSON, PRESIDENT, IN THE CHAIR.

The SECRETARY announced the election of the following ntlemen:—

MEMBERS—

MR. ARTHUR HALL, Colliery Manager, Nuneaton Colliery, near Nuneaton.
MR. EDWARD MIDDLETON HEPPEL, Mining Engineer, Camerton Collieries, near Bath.
MR. ALEXANDER G. MCTURK, Engineer, c/o Messrs. G. Fletcher & Co., Masson Works, Derby.
MR. ALBERT JOHN NETTER, Deputy Commissioner of Mines, Vryheid, Natal.
MR. SINCLAIR PEARN, Engineer, West Gorton, Manchester.
MR. JAMES THOMPSON, Engineer, Apsley House, Pennfields, Wolverhampton.
MR. WALTER HARRY THOMPSON, Engineer, 65, Kirkstall Avenue, Kirkstall, Leeds.
MR. WILLIAM HOPKIN WALTERS, Manager, Clydesdale Collieries, Springs, Transvaal.
MR. LLEWELLYN HAYWARD WILKINS, Mining Engineer and Metallurgist, Akaroa, Gatcombe Road, Tufnell Park, London, N.
MR. HUBERT TYLDEN WRIGHT, Manager, Dundee Collieries, Dundee, Natal.

ASSOCIATES—

MR. THOMAS BARKER, Under-manager, Cotes Park, Alfreton.
MR. HERBERT FLETCHER, Assistant Manager, Hardwick Collieries, Heath, Chesterfield.
MR. EDWARD STONE, Enginewright, Cotes Park, Alfreton.
MR. HENRY EDWARD WILLIAMSON, Foreman Pattern-maker, Sheepbridge, Chesterfield.

STUDENT—

MR. GERALD N. MARTIN, Claremont Place, Sheffield.

DEATH OF MR. C. SEBASTIAN SMITH.

The PRESIDENT (Mr. W. B. M. Jackson) asked the members pass a vote of condolence with the family of the late Mr. Sebastian Smith, who had recently died, and who had been

a member of that Institution for a great number of years. Sebastian Smith was a member of the Council and a V President of the Institution, in the welfare of which he t very considerable interest, as was shown, amongst other w by the valuable and interesting papers which he had contribu from time to time. He was also a man of much ability, was the inventor of the lime-cartridge for blasting, whicl one time was very largely used; he was also the inventor patentee of a safety-prop arrangement. He moved, theref that the Secretary be asked to convey to the family of C. Sebastian Smith an expression of their sympathy with t in the loss which they had sustained.

The members unanimously signified their approval of resolution by rising.

DISCUSSION OF MR. W. HAY'S PAPER ON "T THREE-PHASE ELECTRIC HAULAGE-PLANT SHIREBROOK COLLIERY, MANSFIELD,"* AND R. HOLIDAY'S PAPER ON "A COMPARISON THREE-PHASE AND CONTINUOUS CURRENTS F MINING PURPOSES."†

Mr. W. Price Abell (Derby) said that the Departme Committee on the Use of Electricity in Mines did not m any suggestion as to the standardization of the periodicity three-phase currents. Both Mr. Holiday and Mr. mentioned the subject of periodicity in connection with t respective installations, and the few installations actually u discussion used variations of 120, 50, 42 and 30 periodic per second. Without going into details, he (Mr. Abell) thou that it was generally recognized that a lower periodicity t 40 was too pulsating and perceptible for glow-lamp work, that a periodicity higher than 60 was becoming too high economical power-work. At the time of the meeting of Departmental Committee he believed that it was gener accepted that a periodicity between 50 and 60 would meet m cases, but the difficulty was to decide whether it was to be

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 282.

† *Ibid.*, 1904, vol. xxvii., page 410.

or 60. One colliery had the former and another the latter, and not being made up of the same multiples, very differently constructed machines were required in the two cases. The difference in periodicity, therefore, meant that the manufacturer could not stock, and the colliery-manager could not buy in the best market. If, therefore, some representative body would offer a strong suggestion in favour of a definite periodicity of either 50 or 60 being adopted, both manufacturer and user alike would be glad to follow the lead offered. There was at present no standardization, but everyone was using a periodicity which he believed to suit him best. There was very little difference in working between 50 and 60 periods, but the difference in manufacture was very great. If the periodicity was reduced to 25, that was good for power, such as coal-cutting, and 25 was a factor of 50. Continental and foreign firms had gone in for 60 periods, but British firms had preferred a factor of 100, such as 25 or 50. If a powerful institution would consider the matter, he felt sure that there would soon be a general desire to accept what was recommended by them.

With regard to Mr. Holiday's remarks on three-phase coal-cutters, he (Mr. Abell) might say that the practicability of three-phase currents for such a purpose was fully assured. In the discussion at a previous meeting it was stated that three-phase motors required more room than motors using a continuous current. As a matter of fact, while certain parts might be larger in the case of a three-phase motor, the actual volume of space taken up by it was distinctly less than that required by a continuous-current motor. Although perhaps a little outside the question of a comparison between the two kinds of motors, there should not be overlooked the possibility of using an electrically driven air-compressor inbye, thus doing away with any danger which might be supposed to arise from coal-cutting by electricity at the working-face. The idea had been aimed at by most of the leading coal-cutting engineers for 15 years, and it had now been brought within the range of practicability by the Reavell air-compressor, which could be driven by either a continuous-current or a three-phase motor.

Mr. Maurice Deacon (Sheepbridge) remarked that he had been using both three-phase and continuous-current plants for

many years, but during the last 5 years he had abandoned continuous current in all new power-plants which he had erected, and had adopted three-phase as being more economical in repairs, and more convenient for intermittent loads, for the reason that a very much greater overload could be put upon a three-phase machine without damaging the armature, than could be put upon a continuous-current machine. There was the further point that, in a fiery mine with a three-phase system, there was an absence of the risk of sparking from the commutator. The risk from the sparking of a commutator might perhaps be more or less imaginary, but it was a factor of some importance in deciding upon the description of plant to be adopted in a fiery mine. In the use of three-phase plant there was no detriment to the armature in running up, constantly and frequently, to 100 per cent. of overload. When he said "constantly and frequently," he did not mean continuously; but, taking, for instance, the case of a haulage-plant, if they had an overload of 100 per cent. at the start of every journey they could go on working their motor with that starting-overload for a good many years, without the slightest injury to their armature. It was a very great advantage in the case of colliery-work, because they never knew exactly what load was going to be put upon their machines when they were starting a set out of the bottom of a dip. A few extra tubs might be put on, contrary to orders; or a tub might run off the road, and a sudden load might be thrown upon the machine. In a continuous-current machine that would probably result in the fusing of the commutator. Then he found that the cost of repairs was considerably less in the case of three-phase plants than in continuous-current plants. The periodicity of Westinghouse machines was 30, and some time ago, having erected a Westinghouse plant, he was in some doubt as to whether he could satisfactorily light with a 30 cycles machine; but he was assured that there was no objection to that whatever. He adopted it for lighting, and it had been working for 3 or 4 years with the greatest satisfaction, and he had proved that 30 periods per second was suitable for lighting purposes, when used direct.

There were many mines where a manager who had a high regard for the safety of his men would not venture to put a

cutting machine at the face, driven by electric power, or to put a motor in the return air-way. He made a rigid when he put down an electric plant in South Wales some ago, that every motor and all the cables should be placed take-airways, and that no motor should be placed close up he face. The absence of the minutest sparking in this -phase plant had convinced him that there was no risk in ting it, even in fiery mines, with the precautions previously ed.

he three-phase plant at Glapwell colliery comprized a 200 watts machine driven by a Robey compound engine, and in ecial non-induction test made in order to ascertain the iency of the plant on a full load, the following results were ined: —407 indicated horsepower; 290·71 electric horsepower uced at the generator; and a mean total of 386·4 units. The m-consumption was somewhat high, being 28·58 pounds per cated horsepower. It may have been that the engine was tle under power, and that it was not working so economic- at full load as when on a normal load; but ordinarily the ne worked with a steam-consumption of under 14 pounds indicated horsepower. The loss between the engine and generator was 10·97 per cent., and the over-all efficiency ne machinery was 78·38 per cent. Omitting interest on al and depreciation, because these varied with varying cir- stances; and taking coal at the high price of 4s. per ton adding the cost of the engineman and stoker, and other ar and cost of stores, the total cost of the running charges 3s. 9·42d. per hour, or 0·21d. per Board of Trade unit; and, erest and depreciation were added, he did not think that the would exceed 0·30d. or 0·40d. per unit. Tests were made the temperature-rise in the generator above the temperature e air in the engine-house, and these showed the following ts:—Armature-iron, 15° Fahr.; armature-coils, 12° Fahr.; eto-windings, 14° Fahr.; exciter, 15° Fahr.; and exciter- ets, 15° Fahr. These were extremely satisfactory rises, it was remembered that the Admiralty limit was 40° Fahr. e had some tests made on a small continuous-current plant, ing at 200 volts and driven by a single-cylinder engine. The wing results were obtained:—68·70 indicated horsepower; electric horsepower at the generator; a mean total of 40·15

units; and the over-all efficiency of the machinery was 7[illegible] per cent. The running cost, taking coal at 4s. per ton, a[illegible] adding wages and the cost of stores, was 1s. 5d. per hour, a total cost of 0·431d. per Board of Trade unit. The tempe[illegible] ture-rises in this case were as follow:—The armature-i[illegible] 13° Fahr.; armature-coils, 13° Fahr.; magneto-winding, [illegible] Fahr.; and commutator, 25° Fahr.

In a three-phase plant in South Wales, already referred the total cost of working on half load, with coal at 9s. per [illegible] and without interest and depreciation, was a little above ½d. [illegible] unit, and on full load, about 0·35d. per unit.

These figures would be of interest to members from a co[illegible] mercial point of view, because power companies were propos[illegible] to charge 1d. per unit for power, and some collieries were payi[illegible] that amount. There was an advantage in taking power from[illegible] company, and being relieved of the capital expenditure nec[illegible] sary to produce it; still he ventured to suggest that where t[illegible] capital could by any possibility be obtained, a colliery using a[illegible] considerable amount of power could produce it at a much low[illegible] cost than 1d. per unit.

Mr. G. C. Allsebrook said that, when he was thinking using a coal-cutting machine, a representative of the Briti[illegible] Thomson-Houston Company told him that a meeting engineers had practically decided upon a standard periodici[illegible] of 50, and that, in consequence, users would be able to g[illegible] quicker delivery of motors at smaller prices. On the oth[illegible] hand, the makers of the coal-cutting machine asked for curre[illegible] at 25 periods per second, stating that the lower periodicity ga[illegible] better starting-torque, allowed more clearance between the ro[illegible] and the stator, permitted of the motor being made smaller fo[illegible] given horsepower, with less gearing down between the ro[illegible] and the coal-cutter bar, and did not necessitate the use[illegible] slip-rings. Mr. M. Deacon stated that, with a periodicity of [illegible] he had no difficulty in using the current for lighting; but (Mr. Allsebrook) asked whether a periodicity of 25 would [illegible] also be satisfactory for lighting the junctions and haulage-ro[illegible] of a mine? He also asked whether in a naked-light mine, w[illegible] a good roof, it would be better to put the conductors in intake-airway which was a haulage-road, or in a return-airw[illegible]

which was not a haulage-road? He had been reading the proposed Special Rules for the use of electricity in mines, but he was unable to ascertain from them whether it would be necessary to use armoured cables in mines, where the roof was good and the cables could be suspended from the bars.

Mr. A. Lucas understood that the tests referred to by Mr. M. Deacon were non-inductive tests and that an artificial load was put on the machines. In colliery-working, the load is an inductive one; consequently, the results given were somewhat higher than would be obtained under ordinary working conditions. The power-factor of induction-motors varied from 0·75 to 0·90; therefore, the non-inductive results given by Mr. Deacon should be multiplied by the power-factor, and would reduce the output by that amount. The results would still be in favour of three-phase plant, but not to the extent of the figures given. A periodicity of 50 cycles was standardized by the Electrical Standards Committee, and a report of their resolution affecting this was published in an intermediary report in July, 1904; 25 cycles were considered permissible under conditions where it would be more satisfactory, and it was particularly considered in connection with heavy railway and similar work, where there was no lighting. It was possible to get a fairly satisfactory lighting result with incandescent lamps with a periodicity of 30 cycles, but at 25 cycles the vibrations were quite marked; and with arc-lamps, the periodicity must exceed 40 cycles, in order to get them to work satisfactorily. The object was to fix on a periodicity which would be workable for either arc or incandescent lighting as well as for power, and that object seemed most likely to be attained with a periodicity of 50 cycles.

Mr. W. Hay (Shirebrook) asked whether any member had received a shock from a three-phase coal-cutter? He had been afraid of the men getting a shock from the motor, and hesitated on that account, for he hardly looked upon a three-phase electric coal-cutter as a pleasant companion at the coal-face. He (Mr. Hay) had had one or two disagreeable shocks of 500 volts with a direct-current plant, but he would rather that someone else tried the experiment with an alternating-current plant. The work was done satisfactorily with an air-compressor driven by an electric motor near the coal-face, but he would

hesitate before adopting that system on a large scale, except where a sudden and serious outburst of gas was likely to happen at the coal-face. It was necessary to have a man constantly in charge of the air-compressor, and ten or twenty machines would require a corresponding number of attendants. There was, no doubt, great loss in conveying compressed air from the surface to the faces, but he doubted whether a system of using a number of air-compressors, electrically driven, would not cost very much more. He thought that with pipes of large capacity, a modern air-compressor and a well-constructed engine, the result would be very much in favour of the direct compressed-air system rather than in favour of that utilizing the intermediate aid of electricity.

Mr. A. Lucas said it was almost impossible to define when current became dangerous to life. He had known a man to be killed with 250 volts, while he himself had sustained a shock at 2,000 volts without injury. A great deal depended on how the shock was received, what amount of contact was given and what resistance there was in the body. In some cases, with a very high voltage, the shock was likely to pass over the surface, whereas at a lower voltage it was more likely to go through the system. With a low periodicity, say, of 25 cycles, the shock was very severe; but with a higher periodicity the shock was less severe.

Mr. W. Price Abell said that Mr. Hay mentioned that an electrically-driven air-compressor at the coal-face necessitated the presence of an attendant, and so increased the cost very materially. The advent of the Reavell air-compressor, however, had overcome the difficulties experienced by Mr. Hay with the ordinary old type of air-compressor, as it was capable of being left to itself and would still work satisfactorily. By using a modern engine and generating electricity on the surface, an efficiency of 75 per cent. could be obtained at the coal-cutter by working the air-compressor inbye. Whereas by compressing at bank, there was a great loss caused by the cooling of the air. If air was compressed inbye, there was no reason why the air should not be taken at a temperature of 400° or 500° Fah., expanded in the cylinders, and exhausted at the temperature of the air in the mine. By that means, the loss, which was inseparable from air-compression on the surface, was avoided.

At a colliery, not far from Nottingham, where there was a combined continuous-current and three-phase plant, they could change over from one to the other in about half-an-hour; but the fact that the three-phase plant was usually worked showed a preference for the three-phase plant.

The PRESIDENT (Mr. W. B. M. Jackson) said he had never had any experience, except with direct-current machines: but with these machines he had been coal-cutting, pumping and hauling for about 10 years with satisfactory results. He was ready to believe that there were advantages in the three-phase system; but direct-current machines, if kept in an efficient state and not overloaded, from his experience, gave excellent results. It was well to take every precaution with regard to the use of electricity underground; but he was of opinion that the danger of sparking from a commutator was, perhaps, somewhat exaggerated. He always felt that the cables required the greatest attention, both in erection and maintenance; otherwise they were very liable to prove a source of danger. No doubt, with regard to shocks, a great deal depended upon the individual who received the shock, the condition of his health and the state of the ground. Mr. W. Price Abell had mentioned the subject of the insertion of another Special Rule amongst those which had already been suggested; but he hoped that they would have no more rules, for it looked as if there were too many already. He, however, believed that the proposed Special Rules regulating the use of electricity in mines would in the end be much more workable and reasonable than was at one time anticipated.

DISCUSSION OF MR. W. BLAKEMORE'S PAPER ON "THE FERNIE EXPLOSION."*

Mr. JAMES ASHWORTH, with the aid of a plan of the mine, indicated the character of the different parts of the workings, the direction taken by the explosion, and the effects produced along the route. He remarked that those who examined the plant accompanying Mr. Blakemore's paper, and contrasted it

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 450; 1903, vol. xxvi., page 426.

† *Ibid.*, 1902, vol. xxiv., plate XII., page 460.

ith the map before them would see numerous points of differ-
nce. Mr. Blakemore's plan was called "a sketch" certainly,
ut it was a pity that greater pains had not been taken to
nake it more accurate. The main question which would probably
interest the members was, whether the explosion was what might
be termed a coal-dust or a gas explosion. Mr. Blakemore stated
that he had arrived at the conclusion that it was a coal-dust
explosion, but he (Mr. Ashworth) contended that the whole of
the evidence pointed to an explosion of gas. Mr. Blakemore
asserted that the mine was dry and dusty, and yet in another part
of the paper he went on to show that it was neither dry nor dusty.
The fact was that the mine was in some parts quite wet, in other
very damp, and in others what is understood as dry. These are
were coloured on the plan placed before the members, and
showed the extent of the workings thus affected. If it had been a
coal-dust explosion, plenty of evidence would naturally have been
expected to be found along the main intake and haulage-road,
where the conditions were always considered the most favourable
for its propagation. He (Mr. Ashworth) said that, as a matter
of fact, there was practically no evidence of the explosion having
passed along the main haulage-roads. The direction in which
the stoppings were blown showed that the force had crossed the
roads from east to west; and the overcast, which was con-
structed of seven heavy sections of permanent-way rails, used as
girders (two being placed under each of the side-walls, and three
equidistant girders carrying the wooden flooring) had had its
floor blown down into the haulage way underneath, whilst the
side-walls were not blown out. It is quite clear, therefore, that
the force which did this damage came from the return-airway,
and not from the intake-airway. Again, if the force had come
along the haulage-way, as Mr. Blakemore contended that
it had done, then the side-walls of the overcast must have been
blown in an outbye direction. The stoppings on each side of
the main haulage-road were carried away, not in the direction of
the old workings, as they ought to have been in a coal-dust ex-
plosion, but by a force crossing the road from east to west, and
every stopping, excepting one, was blown westward: the one
exception was not thus blown, because there was no correspond-
ing opening on the east side of the road. Mr. Blakemore stated
that the mine was free from gas, whereas he (Mr. Ashworth)
found that every virgin coal-face which he visited was maki

gas. The expert engineers, sent by the Government to investigate the mine and ascertain the cause of the explosion, reported that the explosion was one of gas and not of coal-dust, and that it had originated near the face of the McDonald level, where a blower had been reported. Mr. Blakemore said that no matches were found in this part of the mine; but this was an error, as matches were found in both pockets of the trousers of Milroy, who was found behind the brattice in such a position as that in which he might be expected to be found if lighting his pipe; and it was at or near this point that the explosion was believed to have originated. He (Mr. Ashworth) took with him one of his alcohol-lamps, also an Ashworth-Clowes hydrogen gas-testing lamp, and with these he found 1 per cent. of gas in the whole of the return-air at the foot of the upcast-shaft, and a larger percentage in the old workings. Mr. Blakemore referred to the occurrence of a number of "local" explosions, and stated that these had given rise to some doubt as to the cause of the explosion; but this mystery was easily dissipated and accounted for, when it became known that practically every working room or chamber in the mine contained a powder-can, and that all these powder-cans, with one exception only, were exploded, and the one which escaped did so because it was cached in a pack-wall. He (Mr. Ashworth) had brought home the remains of one of these cans, and any one who wished to see it might have ocular demonstration that its powder-contents had been exploded. The return-air current was completely saturated with water-vapour, so much so that water was condensed on the cold strata at the foot of the upcast shaft, and to such an extent that it dripped from the roof.

Mr. M. Deacon thought that there was very little doubt that it had been a gas-explosion. If it had been an explosion of coal-dust, the dampness of the roads would, in all probability, have arrested its progress, or at least have materially checked it long before it reached the upcast-shaft. Wherever a road was naturally wet, or a system of watering was adopted, the effect of a coal-dust explosion ceased almost immediately. In this case, the explosion went down the return-airway, a damp road, whereas if it had been a coal-dust explosion it would have followed the main haulage-road, which was said to have contained a lot of dust in places.

Mr. A. Chambers (Eastwood) said that if the mine had been worked on the Nottinghamshire longwall system the explosion would have blown out everything in the straight road. But as the coal was cut into large chambers, the explosion was distributed over a vast area of workings. Possibly, if no coal-pillars had been left, and with complete solidification of the goaf as in longwall working, the explosion would not have taken place.

Mr. James Ashworth stated that water had no apparent deterrent effect on the explosion in any part of the mine.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.

EXCURSION MEETING,
JANUARY 22ND, 1904.

The members visited the works of the British Westinghouse lectric and Manufacturing Company, Limited, at Trafford ark, Manchester, accompanied by members of the British ciety of Mining Students.

RAFFORD PARK WORKS OF THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED.

A decade ago, Trafford Park, the ancestral home of the Trafford family, on the outskirts of Manchester, formed a lendid example of an English demesne, but its proximity to e Manchester Ship Canal was fatal to its continuance as a idential estate. The result has been that works of every scription have sprung up on all sides, and amongst these is establishment of the British Westinghouse Electric and nufacturing Company, Limited. The buildings were comnced in 1901 and were carried through at record speed, the rk being finished between 12 and 18 months afterwards. me idea of the size may be gathered from the fact that some 000,000 bricks, 9,000,000 square feet of timber, 300,000 uare feet of glass-roofing and 17,000 tons of steel were used their erection, giving employment to nearly 4,000 workmen. The office-building, comprizing the various managerial, gineering and commercial departments, etc., is 250 feet long, feet deep, 6 storeys high, and covers an area of nearly $1\frac{3}{4}$ res.

The large machine-shop, 430 feet wide and about 1,000 feet ng, is divided into five aisles or bays. There are separate alleable-iron, steel- and brass-foundries, a large forge, pattern-

shops, box-factory, and various smaller shops. Altogether, the buildings cover more than one-third of the total ground-area, and an extensive railway network, comprizing some 10 miles of track, serves for the conveyance of patterns, castings, and partly or wholly finished material from one point to another, this network being also connected with the local railways at two or three points.

The number of hands at present employed is between 4,000 and 5,000, and many of them reside in the newly-built cottages and houses, which, together with an hotel, clubhouse, etc., have been erected near the works.

The machinery is electrically driven, the generating plant for supplying motive power and light being larger than is found in many towns.

Practically every machine and appliance used in heavy electrical engineering is built or manufactured at these works, including steam-turbines for driving electrical generators or any other machinery, steam-engines and gas-engines. Four Westinghouse steam-turbo-electric generators, each having a capacity of nearly 7,000 horsepower, have been supplied to the Neasden power-station of the Metropolitan Railway Company, London; and similar machines of 60,000 brake-horsepower are being erected at the Chelsea power-station of the London Underground Electric Railways, Limited.

ESTER GEOLOGICAL AND MINING SOCIETY.

EXCURSION MEETING,
JUNE 11TH, 1904.

nembers visited the sites of the Howden and Derwent
i respectively, near Bamford, of the Derwent Valley
oard, under the leadership of Prof. W. Boyd Dawkins,
rs. Winser and Richards, resident engineers.

DERWENT VALLEY WATER-SCHEME.

Derwent Valley water-scheme is for the supply of water
owns of Leicester, Derby, Sheffield and Nottingham,
ounties of Derby and Nottingham. The scheme in-
ıe construction of (*a*) five reservoirs for impounding
s of the rivers Derwent and Ashop; (*b*) about 100 miles
ıct for distributing the water to the various authorities:
20 acres of filter-beds at Bamford; and (*d*) a service-
at Ambergate. The ultimate daily supply of water
uthority will be approximately as follows:—Leicester,
gallons; Derby, 6,800,000 gallons; Sheffield, 6,800,000
Nottingham, 3,900,000 gallons; Derbyshire, 5,000,000
and Nottinghamshire until 1930, 1,000,000 gallons; a
33,300,000 gallons.

will be three reservoirs on the river Derwent (the
Derwent and Bamford reservoirs); and two reservoirs
ver Ashop (the Haglee and Ashopton reservoirs).

he first instalment, only the Howden and Derwent
i will be required, and these are now in course of
ion. Howden is the up-stream reservoir.

oundations of both dams are in the Yoredale series of
niferous system. The foundation of the Howden dam
laid at a depth of 68 feet below the river-bed. A
ench, 6 feet wide, on the north side of the foundation

had been sunk to a depth of 88 feet below the river-bed, and was being filled with concrete to prevent water from percolating through the shales under the main body of the dam. The trench for the Derwent dam was about 60 feet deep, and was being cut by means of channelling-machines.

Prof. W. Boyd Dawkins said that the two very remarkable examples of folding and faulting shown in the puddle-trench lines of the two reservoirs were caused by relaxation of pressure, brought about by the removal of the rocks during the excavation of the valley by the river. The foldings, strongly marked at the surface, disappear at a depth of 90 feet in the upper, and at a depth of 60 feet in the lower, of the two puddle-trenches. In both cases, the thicker beds of sandstone below are continuous and offer a good foundation for the masonry-dam. In both cases, too, the folds are distinguished by small faults from the unfolded rock in the sides of the valley.

He (Prof. Boyd Dawkins) had observed a like superficial folding of the strata at the bottom of valleys carved out of the shales and thin interbedded sandstones of the Millstone Grit and Yoredale rocks in several other places, such, for example, as Langsett reservoir, in the valley of the Little Don. He found, as a matter of experience, that these folds were superficial, and disappeared as the puddle-trench was carried down from the surface. It was therefore obvious that they were not due to deep-seated movements of compression resulting from the contraction of the earth. They were due to the relaxation of pressure caused by the removal of the rock from the area of the valley, and were analagous, in every respect, to the "creep" in coal-workings caused by the removal of the coal, in consequence of which the surrounding strata crush down into the area of relaxed pressure and ultimately fill it up. This phenomenon may be studied in any coal-pit where there is a pressure of more than 1,000 feet of rock.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.

EXCURSION MEETING,
AUGUST 13TH, 1904.

The members visited Sparth Bottoms, Rochdale, under the leadership of Mr. W. H. Sutcliffe, F.G.S., and examined the *Carbonicola-acuta* bed, and others, in a quarry where many valuable fossils have been discovered. They also inspected a large collection of fossils, etc., deposited in the Rochdale museum.

Afterwards, under the leadership of Mr. S. S. Platt, M.Inst. C.E., F.G.S., the borough engineer, the members inspected two new bridges over the river Spodden and other works, constructed of Hennebique ferro-concrete, the new tramcar-shed, the interior of the Town Hall, etc.

SPARTH BOTTOMS QUARRY, ROCHDALE.

BY WALTER BALDWIN.

The Middle Coal-measures are repeatedly thrown in between Rochdale and Heywood by several large faults, which run north-west and south-east, and are probably of the same age. The Middle Coal-measures at Sparth have been brought in by one of these faults, which has its downthrow to the north-east. It starts in the Nayden valley, close to Greenbooth mill, near Norden, and runs by Cutgate, skirting the north-western border of the Rochdale cemetery, crosses the Manchester road about a mile from the Rochdale Town Hall, and is eventually lost in the Thornham district by reason of the thick deposits of drift, which have rendered our knowledge of the solid geology of that district so very imperfect.

The Royley mine comprizes:—Coal, 2 feet 7 inches; fire-clay, 4 inches; and coal, 1 foot 6 inches; a total of 4 feet 5 inches. It crops out under the new tramway-depôt in Mellor Street, close by Spotland Bridge; and passes round by the corner of Ashworth Street and Mount Street. The average dip for this district is about 1 in 9 to the south-west, although in some places the dip has undergone an alteration both in magnitude and direction.

The *Carbonicola-acuta* bed lies about 135 feet above the Royley mine. The Old Neddy seam was pierced when the shaft at Brimrod Wood was sunk, and it showed that the distance between the Old Neddy seam and the Royley seam was 260 feet.

Prestwichia rotundata has come from the highest beds, which are seen exposed.

Eoscorpius sparthensis was found 8 feet above the *Carbonicola-acuta* bed.

Euphoberia ferox came from the *Carbonicola-acuta* bed.

***Spiroglyphus* came from the same bed, and also occur at a higher horizon.**

***Belinurus lunatus* (*Belinurus bellulus* of — König) was found in the *Carbonicola-acuta* bed.**

Pygocephalus and *Strepsodus*-scales came from the same horizon as *Prestwichia*.

HENNEBIQUE FERRO-CONCRETE CONSTRUCTION.

By S. S. PLATT.

There seems a tendency for the universal reign of steel to be giving way somewhat to a return of masonry-construction, not to brick and stonework, but to an artificial stone, that is, concrete strengthened by steel: variously called "ferro-concrete," "concrete-steel," "armoured concrete," "fortified concrete," "reinforced concrete," and so forth, depending upon some variety in the method of union of the two materials of which it is composed.

Concrete is not a new constructional material, but it is comparatively weak when exposed to tensile strains. However, in

on with steel, in which the steel, in any form, is
nbedded in concrete, the concrete stiffens the steel,
teel reinforces the concrete, thereby producing a con-
l material of great value, economic adaptability and
. An important consideration is that once properly
first cost is the only cost. A great advantage over
:ruction, which, if exposed to atmospheric influences,
constant outlay for maintenance.
ler to attain successful application of this combined
onal material, it is absolutely necessary that the
ıld be entrusted only to persons properly qualified to
proportions and distribution of the reinforcement;
'ork must be carried out (under qualified supervision)
ctors experienced in this class of work. Any depar-
ı, or non-observance of, the essentials of first-class
dly reduces the strength of this most valuable con-
l material in a manner which cannot be determined
.tion.

o bridges carrying a new street over the river Spodden
land Bridge, Rochdale. The special reason for adopt-
)-concrete construction arose from the abnormal
) due to the presence of colliery workings in the Royley
ı depth of from 30 to 40 feet below the river-level: the
contain water which is being pumped and used for
purposes. To rest a bridge on ground so badly honey-
would have been to court disaster. Ferro-concrete
nches square, 40 to 60 feet deep (spaced approximately
: centres longitudinally and transversely) were placed
)les through the colliery workings and driven at least
ıto the solid stratum below. Upon these piles each
was calculated to give a resistance equal to a dead
ver 90 tons, were built the abutments of the bridge.
lges are the first, in this country, constructed of ferro-
'rom the foundations to the superstructure. They are
rst that have been built with slab-arches, that is, arches
ibs or beams.

e covering of the river Roch, in the centre of the town,
:he Rochdale and Wellington Bridges, so as to form a

central open space for the distributing centre of the electric tramways of the borough and district, was also carried out in ferro-concrete, as it appeared to possess such advantages of economy in construction and maintenance (particularly with reference to the avoidance of the requirement of regularly painting the underside of a structure exposed to the gaseous emanations from a river largely used for industrial purposes), in place of the ordinary steel-decking construction.

The covering is about 300 feet long and 60 feet wide. It consists of a continuous slab of ferro-concrete, 6 inches thick, supported by main beams, 16 inches deep by 14 inches wide, spaced approximately 20 feet, from centres to centres, transversely and 13 feet, from centres to centres, in the longitudinal direction of the river. The main beams rest upon the old side-walls and two intermediate pillars; the secondary beams are 10 inches deep and 7 inches wide, spaced about 5 feet from centres to centres, support the slab between the main beams: the whole being built of ferro-concrete.

After completion, the above-described structures were tested by passing over them a load of 32 tons on a boiler-wagon, with a wheel-base measuring 8½ feet by 6½ feet, drawn by a traction-engine weighing 13 tons, and the footpaths were loaded up to 140 pounds per square foot. The maximum observed deflection was only about $\frac{1}{25}$ inch, and, shortly after the removal of the loads, the structures resumed their original position. These tests are considered very satisfactory.

The saving in initial cost was about 25 per cent. over the estimate for steel-construction.

The works were initiated by, and carried out under the superintendence of, the writer, with whom has been associated Mr. L. G. Mouchel, C.E., London.

ANCHESTER GEOLOGICAL AND MINING SOCIETY.

ANNUAL GENERAL MEETING,
HELD IN THE ROOMS OF THE SOCIETY, QUEEN'S CHAMBERS,
5, JOHN DALTON STREET, MANCHESTER,
OCTOBER 11TH, 1904.

GEORGE H. HOLLINGWORTH, RETIRING PRESIDENT, IN THE CHAIR.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

Mr. VINCENT BRAMALL, Mining Engineer, Pendlebury Collieries, Pendlebury, near Manchester.

Mr. ROBERT LORAINE GAMLEN, Mechanical and Electrical Engineer, 78, King Street, Manchester.

Mr. FREDERICK H. HOLLINGWORTH, Mining Engineer, The Oak, Hollinwood, near Oldham.

Mr. GERALD H. J. HOOGHWINKEL, Mining and Electrical Engineer, Dacre House, Victoria Street, London, S.W.

Mr. WILL SETTLE, Mining Engineer, Prestwich.

Mr. RICHARD SYDNEY SPENCER, Mining Engineer, New Moss Colliery, Audenshaw, near Manchester.

STUDENTS—

Mr. HUGH CRANKSHAW, Mining Student, Montcliffe, Horwich, near Bolton.

Mr. JAMES ROBERT HARK, Mining Student, 92, Market Street, Hindley, near Wigan.

The Annual Report of the Council was read as follows:—

NNUAL REPORT OF THE COUNCIL, 1903-1904.

At this, the sixty-sixth Annual Meeting, the Council have sure in presenting their report on the proceedings of the ety during the year, and also in congratulating the members n the satisfactory progress which has been made.

The membership of the Society has been considerably mented during the year, no fewer than 30 new names having n added to the list. Against this, must be taken the inevit-

able losses by death and resignation amounting to 10, of which death claims 3. The register now comprizes 8 honorary, 11 life and 228 ordinary members, making a total of 247, being a net increase of 20 over the last year.

Of the deceased members, Mr. James Tonge will be remembered as a past-president and for some years one of the Society's honorary secretaries, and also for the sustained interest which he evinced in the work of the Society for many years; the others being Messrs. F. W. Scott and J. Evans.

The Treasurer's statement of accounts shows that the financial position of the Society is thoroughly satisfactory.

The Annual Meeting, 8 Ordinary Meetings and 1 Special Meeting were held in the Society's rooms, when valuable papers were read and discussed, some of them being of more than local interest. Also, following the practice of recent years, an extra meeting was held in the Museum Buildings, Owens College, on February 19th, when an address, with lantern illustrations, was given by Mr. George H. Winstanley, on "The Mechanical Equipment of Collieries." The attendances have been very satisfactory.

In his Presidential Address, Col. George H. Hollingworth, F.G.S., re-introduced the question of federating the Society with The Institution of Mining Engineers; he also referred to the valuable work being carried on by the Society, and named a variety of subjects as suitable for papers, such as the working of mines at great depths, the correlation of the upper series of the Lancashire Coal-measures, coal-cutting by machines, and the application of mechanical appliances generally. The majority of these subjects have been discussed.

During the session, valuable papers and short communications have been read before the Society and published in its *Transactions*, on geological subjects by Mr. W. J. Sutton, Mr. Henry Hall, H.M.I.M., I.S.O., Mr. Joseph Dickinson, F.G.S., Mr. Herbert Bolton, F.R.S.E., Mr. Walter Baldwin, F.G.S., Prof. W. Boyd Dawkins, M.A., D.Sc., F.R.S., etc., Mr. J. Barnes, F.G.S., Mr. John Gerrard, H.M.I.M. and Mr. B. Hobson, M.Sc.; and on mining subjects by Mr. W. H. Johnson, B.Sc., Mr. Alfred J. Tonge, Mr. George H. Winstanley, F.G.S., Mr. Maurice Georgi, M.Inst.M.E., etc., Mr. James Tonge, F.G.S., Mr. W. H. Jones, Mr. Joseph Dickinson, F.G.S.,

Mr. John Rigby, J.P., and Mr. Philip C. Pope. The late Mr. James Tonge read a report, as the Society's Delegate to the meeting of the British Association for the Advancement of Science, held at Southport in September, 1903.

The complete list of the papers and other contributions is as follows:—

"A Carboniferous Air-breather." By Mr. Walter Baldwin, F.G.S.
"The Palæontology of the Lancashire Coal-measures, Parts I., II. and III." By Mr. Herbert Bolton, F.R.S.E.
"The Physical and Chemical Properties of the So-called Coal-deposit Exhibited by Mr. Henry Hall, I.S.O." By Prof. W. Boyd Dawkins, D.Sc., M.A., etc., and Mr. Jonathan Barnes, F.G.S.
"Eruption attributed to a Vacuum." By Mr. Joseph Dickinson, F.G.S.
"Tapping Fluids under Pressure." By Mr. Joseph Dickinson, F.G.S.
"The Cohesion of Strata overcome by Pressure and Other Causes." By Mr. Joseph Dickinson, F.G.S.
"The Application of Electricity for Winding and other Colliery Purposes." By Mr. Maurice Georgi.
"Fossils found above the Bradford Four-feet Coal at Bradford Colliery, near Manchester." By Mr. John Gerrard, H.M. Inspector of Mines.
"Abraded Coal." By Mr. Henry Hall, I.S.O., H.M. Inspector of Mines.
"A Glacial Boulder from Red Bank, Hanging Ditch, Manchester." By Mr. Bernard Hobson, M.Sc., F.G.S.
"Presidential Address." By Col. George H. Hollingworth, F.G.S.
"A Machine for Testing Miners' Safety-lamps." By Mr. W. H. Johnson, B.Sc.
"Practical Comparisons of Continuous-current and Polyphase Electric Systems, as applied to British Collieries." By Messrs. Philip C. Pope and Norman D. Cameron.
"Outburst from Duncrue Old Rock-salt Mine, after being Tapped for Brine." By Mr. John Rigby.
"Geology and Mining of Vancouver Island." By Mr. W. J. Sutton.
"Coal-cutting by Machinery." By Mr. A. J. Tonge.
"Report of the Delegate to the Conference of Delegates of Corresponding Societies of the British Association for the Advancement of Science, Southport, 1903." By Mr. James Tonge.
"Education in Coal-mining." By Mr. J. Tonge, Jun., F.G.S.
"Mining Examinations, with Special Reference to the Board of Education Examination in Mining." By Mr. George H. Winstanley, F.G.S.
"The Mechanical Equipment of Collieries." By Mr. George H. Winstanley, F.G.S.

Numerous specimens of rare fossils were exhibited by Mr. John Gerrard, H.M.I.M., and Mr. Walter Baldwin, F.G.S.

In addition to the usual increase of the Library by changes, which continue to be received, special mention may be made of the donation to the Society of a large number of volumes of the proceedings of the Institution of Civil Engineers by Lieut.-Col. Sir Lees Knowles, Bart., M.P., which materially add to the interest and value of the Library.

The Council have pleasure in congratulating Lieut.-Col. Sir Lees Knowles, Bart., M.P., a member and co-trustee of the Society, who has had conferred upon him the dignity of a baronetcy.

The Council, having been assured that it was the desire of a large number of the members that the question of federating the Society with The Institution of Mining Engineers should be reconsidered, this important subject was carefully investigated, and having examined the general scheme of the Institution, they concluded that in a large measure it was in accord with the Society's objects and that the Society might be affiliated with The Institution of Mining Engineers with mutual advantage. After issuing a lengthy report prepared by Messrs. Hollingworth, Gerrard, Mitton and Saint for their information, fully explaining the subject and canvassing the members thereon, and finding that a large majority of the votes were given in favour of the proposed change, your Council authorized the President to make formal application, on behalf of the Society to join The Institution of Mining Engineers, and the application was cordially acceded to.

It seems desirable to point out for the information of the members that The Institution of Mining Engineers was founded on July 1st, 1889, its principal object being "the advancement and encouragement of the sciences of mining, metallurgy, engineering and their allied industries." It now comprizes the following mining societies, arranged alphabetically, namely:—The Manchester Geological and Mining Society; the Midland Counties Institution of Engineers; the Midland Institution of Mining, Civil and Mechanical Engineers; the Mining Institute of Scotland; the North of England Institute of Mining and Mechanical Engineers; the North Staffordshire Institute of Mining and Mechanical Engineers; and the South Staffordshire and East Worcestershire Institute of Mining Engineers.

Under the constitution of The Institution of Mining Engineers, a general scheme has been evolved, which, whilst preserving the corporate individuality of each society, enables mining engineering to take the highest rank as a scientific profession and its members to be more highly appreciated. It affords a means of communication between the various mining

districts of Great Britain, the Colonies and India, and of enabling each to acquaint itself with the superior or peculiar practices of others. It undertakes the sole publication of the proceedings of the federated societies, and a mass of useful knowledge is thus collected together and rendered easy for reference. It also publishes separately the *Transactions* of the respective societies, to which non-federated members belong, a copy of which is supplied to each non-federated member. For each non-federated member the local society pays 10s. per annum to cover the cost of publication.

The respective societies pay for each federated member, who receives a copy of the *Transactions*, a sum of, at present, 19s. per annum; or such other sum per annum as the Council may from time to time determine. The members therefore receive the *Transactions* of all the federated societies for one subscription, which would have cost about £11 per annum prior to the formation of The Institution of Mining Engineers. This Society is responsible for the payment in respect of its members of the annual subscriptions to the Institution.

It is worthy of note that, although federated, each society preserves its local independence, and retains full control over its possessions and proceedings, future publications in the *Transactions* of The Institution of Mining Engineers being excepted.

The interests of those members who do not become members of The Institution of Mining Engineers are not affected by the change. They retain all their privileges, and will continue to receive the *Transactions* of the Society as hitherto. Their annual subscription remains as before, namely, £1 each.

Members can become members of The Institution of Mining Engineers only through one or other of the federated societies. The classification of membership and the annual subscriptions to this Society which, with the consent of the members, have been decided upon are as follows:—Members, £2 2s.; Associate Members, £2 2s.; Associates, £1 5s.; and Students, £1 5s.; for which each federated member will receive a copy of the *Transactions* of the whole of the federated societies, together with those of the General Meetings held in London and elsewhere, and 100 pages of abstracts from foreign publications of great interest to geologists and mining and mechanical engineers;

and now comprised in two annual volumes of about 800 or 900 pages each, which will probably be increased by the inclusion of the proceedings of this Society.

Each member is entitled to attend and take part in the meetings of the federated societies respectively in addition to the three general meetings already mentioned.

It is, therefore, anticipated that, under the new conditions, the influence of the Society will be more effective than heretofore, as it now affords its members a valuable medium of close intercourse with a large number of societies having objects similar to its own.

The Rules of the Society have been altered and amended so as to conform with the general practice, and also so as to harmonize them with those of The Institution of Mining Engineers. The new rules were duly submitted to the members at the special meeting held on September 9th last, and were unanimously adopted.

Three excursions were arranged during the Session. There was a large attendance on each occasion. The first excursion was made jointly with the British Society of Mining Students to the Westinghouse electrical engineering works at Trafford Park, Manchester, under the leadership of Mr. Philip C. Pope. The second excursion took place on June 11th, with the kind permission of Mr. Edward Sandeman, M.Inst.C.E., the chief engineer to the Derwent Valley Water Board, to view the site of the reservoirs now in course of construction near Bamford, under the leadership of Prof. W. Boyd Dawkins and Messrs. Winser and Richards, resident engineers. The third excursion took place on August 13th to Sparth Bottoms, Rochdale, under the leadership of Mr. W. H. Sutcliffe, where the members examined the *Carbonicola-acuta* and other beds, where so many valuable fossils have been recently discovered; and afterwards, under the leadership of Mr. S. S. Platt, inspected two new bridges built of ferro-concrete over the river Spodden, the new car-shed, and the Town Hall, Rochdale. An account of each of these excursions has been printed, immediately preceding the report, in the *Transactions*.

The Council, in reviewing the work of the past year, are deeply sensible of the debt which the general body of members owe to those gentlemen who have assisted in promoting the

objects of the Society, to whom their best thanks are hereby tendered. The Council also express the hope that the increased activity shown may be sustained, and may be an incentive to those members who have not yet been induced to take a personal share in the Society's operations.

The appreciation of the work of the Society is shown by the increasing attendances at its meetings and the larger number of applications which are now received for copies of individual papers. The Council, therefore, confidently ask for the hearty co-operation of the members generally in enlarging the usefulness of the Society.

In conclusion, the Council would urge that a special effort be made by the members to bring to the notice of their friends interested in geology and mining and mechanical engineering, the advantages now afforded by the Society, with the object of inducing them to become members or subscribers. More frequent use of their privileges might be made by members by introducing visitors, especially those who are interested in the discussions, and thus they would aid in advancing the objects of the Society, namely, the collection and diffusion of knowledge respecting geology and mining, and also materially assist in maintaining the high reputation of the Society as a valuable scientific organization of Lancashire and the adjoining counties.

The annexed Statement of Accounts was presented by the Honorary Treasurer.

The Report of the Council and the Treasurer's Statement of Accounts were unanimously adopted.

DR. THE TREASURER IN ACCOUNT WITH THE MANCHESTER GEOLOGICAL AND MINING SOCIETY, FOR THE YEAR ENDING SEPTEMBER 30TH, 1904. CR.

Sept. 30th, 1903.	£	s.	d.	£	s.	d.
To Balance in the bank				99	19	8
,, ,, in Secretary's hands				0	14	3½
Sept. 30th, 1904.						
To Members' subscriptions :—						
Current	188	10	0			
Arrears	19	10	0			
				208	0	0
To Dividends :—						
Birkenhead Railway	22	17	6			
Lancashire and Yorkshire Railway	20	19	3			
				43	16	9
To Bank interest				2	1	8
To Hire of rooms				7	2	0
To Sales of *Transactions*				6	16	0
To Sundries				1	0	9
				£369	11	1½

Sept. 30th, 1904.	£	s.	d.
By Rent, wages, and expenses of rooms	139	10	0
,, Printing *Transactions*	66	0	0
,, Circulars and stationery	13	3	0½
,, Postages, etc.	22	19	11
,, Reporters	9	9	0
,, Library	3	4	10
,, Sundry expenses	6	16	9
,, Balance in bank	103	12	6
,, ,, Secretary's hands...	6	14	4
	£369	11	1½

DR. LIBRARY ACCOUNT. CR.

Sept. 30th, 1903.	£	s.	d.	Sept. 30th, 1904.	£	s.	d.
To Balance brought forward	7	11	3	By Atlas	1	15	9
,, John Gerrard, subscription	2	2	0	,, Books	3	2	10
,, A. Dury Mitton, Do.	1	0	0	,, Books	2	1	6
,, L. B. Wells, Do.	1	0	0	,, Balance, carried forward	4	17	5
,, Bank interest	0	3	6				
	£11	16	9		£11	16	9.

Liabilities.	£	s.	d.
Outstanding accounts :—			
J. E. Cornish	0	4	6
Manchester Corporation	0	9	2
J. Roberts & Son, say	60	0	0
Reporter	1	1	0
	61	14	8
Balance in favour of the Society	1,955	9	7
	£2,017	4	3

Assets.	£	s.	d.
£600 Birkenhead Railway Consolidated Preference Guaranteed Stock, at £121 per cent. ...	726	0	0
£733 Lancashire and Yorkshire Railway 3 per cent. Consolidated Preference Stock, at £86½ per cent.	634	0	0
Library and furniture	500	0	0
Cash in bank	105	12	6
,, in Secretary's hands	6	14	4
Arrears of subscriptions, £73, say	40	0	0
Balance of Library Fund	4	17	5
	£2,017	4	3

The Investments of the Society consist of £600 Birkenhead Railway Consolidated Preference Guaranteed Stock, and £733 Lancashire and Yorkshire Railway 3 per cent. Consolidated Preference Stock. The certificates for these are deposited at the Williams Deacon and Manchester and Salford Bank, St. Ann's Street, Manchester, and were inspected by us on October 11th, 1904.

Audited and found correct, October 11th, 1904.

Geo. H. Hollingworth,
Honorary Treasurer.

Jno. Barnes,
G. H. Winstanley, } *Auditors.*

ELECTION OF OFFICERS, 1904-1905.

The following officers were unanimously elected for the ensuing year:—

PRESIDENT:

Mr. JOHN GERRARD, H.M. Inspector of Mines.

VICE-PRESIDENTS:

Mr. JOHN ASHWORTH. | Mr. GEORGE B. HARRISON. | Mr. SYDNEY A. SMITH.
Mr. ALFRED J. TONGE.

HONORARY TREASURER: Col. GEORGE H. HOLLINGWORTH.

HONORARY SECRETARY: Mr. WILLIAM SAINT.

COUNCILLORS:

Mr. H. S. ATHERTON.	Mr. A. DUBY MITTON.	Mr. CHARLES PILKINGT[illegible]
Mr. HENRY BRAMALL.	Mr. W. OLLERENSHAW.	Mr. JOHN ROBINSON.
Mr. G. W. MACALPINE.	Mr. GEORGE PEACE.	Mr. JAMES TONGE.
Mr. D. H. F. MATHEWS.	Mr. WILLIAM PICKSTONE.	Mr. LIONEL B. WELLS.

HONORARY AUDITORS:

Mr. JONATHAN BARNES. | Mr. GEORGE H. WIDDRINGTON.

Col. HOLLINGWORTH said that, his year of office as President having expired, he desired to thank the members for their support during the session, which he thought had been a busy and satisfactory one.

Mr. JOHN ROBINSON said that he had much pleasure in proposing a hearty vote of thanks to Col. Hollingworth for his efficient services as President during the past year. He had done much to further the best interests of the Society, which was now united with The Institution of Mining Engineers.

Mr. H. STANLEY ATHERTON seconded the proposal, which was carried by acclamation.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,

HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE, DECEMBER 10TH, 1904.

MR. W. C. BLACKETT, VICE-PRESIDENT IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on November 26th and that day.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

MR. SIDNEY ACUTT, General Manager, c/o The Barrett Gold-mining Company, Limited, Godwin River Station, Transvaal.

MR. WARD J. CASEBOURNE, Electrical Engineer, 99, Falmouth Road, Heaton, Newcastle-upon-Tyne.

MR. JOSEPH JOHN HALL, Colliery Manager, Ashington Colliery, Morpeth, Northumberland.

MR. JOHN GEORGE HUTTON, Mine-manager, Torbane, Mudgee Line, New South Wales, Australia.

MR. PHILIP THOMAS JENKINS, Colliery Manager, Gwylfa, Llansamlet, Swansea.

MR. THOMAS BRYANT JENNINGS, Mining Engineer, 1, Atlantic Terrace, St. Ives, Cornwall.

MR. ANDREW MOUNT-HAES, Mining and Mechanical Engineer, 3, Bellasis Avenue, Streatham Hill, London, S.W.

MR. J. W. NIERSES, Colliery Manager, Kendwadah Colliery, Kassunda P.O., District Manbhoom, Bengal, India.

MR. HENRY REES POWELL, Colliery Manager, c/o Mr. Patrick Gariner, 5, Fen Court, Fenchurch Street, London, E.C.

MR. MAX JOHN STEPHAN, Consulting Engineer, P.O. Box 6114, Johannesburg, Transvaal.

MR. RALPH STEPHENSON, Engineer, 6, Ravensworth Road, Dunston-upon-Tyne.

MR. JAMES STOKOE, Colliery Manager, Herrington Lodge, West Herrington, *via* Sunderland.

MR. EDGAR GREENHOW SUTHERLAND, Mining Engineer, West Rainton, Fence Houses, County Durham.

MR. WILLIAM ARMSTRONG WOODESON, Engineer, c/o Messrs. Clarke, Chapman and Company, Limited, Victoria Works, Gateshead-upon-Tyne.

ASSOCIATE MEMBERS—

MR. JAMES MCBLAIN, 33, Crart Avenue, Berea, Durban, Natal, South Africa.

MR. GIDEON A. VOSKULE, Wynberg, Cape Colony, South Africa.

ASSOCIATES—

MR. SAMUEL COADE, Under-viewer, Steel Green, Millom, Cumberland.

MR. HARRY WALTON, Surveyor, Fell House, Medomsley, R.S.O., County Durham.

STUDENTS—

MR. WARDLE HESLOP, Mining Student, Westfield, Benwell, Newcastle-upon-Tyne.

MR. GEORGE THOMPSON NICHOLSON, Mining Student, Dene House, Scotswood-upon-Tyne.

MR. CHARLES ERNEST PUMPHREY, Mining Student, Minster Acres, Ridley Mill-upon-Tyne.

DISCUSSION OF MR. H. W. G. HALBAUM'S PAPER ON "THE ACTION, INFLUENCE AND CONTROL OF THE ROOF IN LONGWALL WORKINGS."*

The CHAIRMAN (Mr. W. C. Blackett) said that Mr. Halbaum had divided the statical pressure of the roof into vertical and horizontal components, and this was quite the correct way of describing the thrusts of the natural arches of strata, thrown so fortunately for them by nature over their pigmy operations in a longwall coal-face (usually expressed by the miner in the phrase that "the roof arches itself"), the spring of one of the face-sides supports of the arch being in various positions according to the structure of the roof-stone, either over, or beyond and parallel with, the longwall face. The end-thrust, due to the radial convergence of the lines of gravity to a common centre, had in all probability not the practical importance which Mr. Halbaum assigned to it, and the whole of the theory which he had built up as to the resultant of the forces thus set moving in the roof should be received with hesitation. There was no doubt whatever that each longwall would be found to present a separate problem of itself, and to generalize on the common behaviour of roof-stone was by no means an easy task, and whilst Mr. Halbaum had been able to do this in a very able

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 205.

way, he put forward several interesting points of theory to which many would take exception. Thus it was open to much doubt whether Mr. Halbaum was correct in ascribing the phenomenon of "draw," whatever his conception of that might be, to the relief of lateral compression caused by the radial convergence just referred to, and not to the successive fractures due to the failure to maintain the goaf-side of the arch so formed. Thus when the face had sufficiently advanced, the complete arch would be found to have been destroyed and only the face-supported part of the arch maintained, which could then be better described as a form of cantilever. On the underside of this cantilever, there was a mass of stone which either fell more immediately into the goaf, or must be supported by artificial means. It largely depended on the position of the break between the underweight of stone, and the under edge of the cantilever-mass above, whether a longwall roof was good, bad or impossible. Thus they might have this breaking-point either behind, or at the coal-face, or beyond it. If it was behind, then there was a varying width or ledge of stone under which work could be safely carried on, and upon the width of this ledge would depend the amount of convenient room for coal-getting operations. If it was at the face itself, there might be much difficulty, and in the worst cases, where the underweight of stone was too heavy for artificial support, it might be impossible to work longwall at all. If it was beyond the face, then artificial support might have to be used, either wholly or partially; the underweight of roof might bend so that it partly rests on the floor behind and on the coal in front, or it might break behind and rest entirely on timber and the coal. There were endless combinations of conditions: experiment alone would determine what was best to be done, and not only were there varying conditions of lines of fracture, but also various qualities of roof-material. Too strong a stone next above the coal might render longwall as impossible as one too weak. The thickness of the seam, too, was all-important, and one method might do in a seam 2 feet thick which was impossible in a seam 4 feet thick. Thus if packs in a seam 4 feet thick, however well built, would allow the roof to subside quite 2 feet, then it was fair to assume that in a seam 2 feet thick, packing could be more or less dispensed with and the roof allowed to subside to

the thill; and, as a matter of fact, in several instances at that moment no packs whatever, except such as were provided by using the goaf-space as a receptacle for heaps of the powdered material from mechanical coal-cutters, existed for lengths of face varying from 200 to 300 feet. No advantage, whatever could be gained by comparing the break of the strata, due to subsidence, to the hade of a fault, and Mr. Halbaum got on to unfortunate ground when he suggested that the line of such break could take an oblique direction over and towards the solid; and he was self-contradictory when he at the same time spoke of a cantilever over the face of work. Having allowed for the difference of opinion already expressed, as it might be applicable to the many practical remarks which Mr. Halbaum subsequently made, there was, of course, very much of value with which to agree, and not the least were Mr. Halbaum's observations on the time-factor in longwall. It was very probable, however, that the continued movement in the roof, after the face-working had ceased, was in many cases due to the coal-face either being slowly disintegrated, or to its being slowly forced into the top or bottom, whichever might be the softer. Recent instances of rapid-face advance by machinery had shewn how greatly the temporary stability of the roof might be improved upon what it had been under the slower advance of manual labour. Although he (Mr. Blackett) had ventured to criticize Mr. Halbaum's views, and disagree with some, he should like to add his testimony to the excellent grasp that Mr. Halbaum had of his subject. It was one on which various individuals might give various views, because each would speak for those examples with which he had become most familiar, and these examples would necessarily differ greatly.

Mr. J. P. KIRKUP asked Mr. Blackett whether, in referring to those fractures, he assumed that they extended any distance above the working seam. His own experience tended to show that goaf-fractures would hardly extend to a seam lying 30 feet above the working goaf. He had frequently worked a seam 30 feet above the goaf, and they could distinguish the subsidence but not the disintegration of the seam, shewing that an actual fracture had not occurred, but that a bending of the strata had taken place.

Mr. W. C. Blackett said he would not like to give any general opinion as to how far any fracture might extend nor as to its direction. He imagined the seam, which the last speaker had in his mind when he said that its effects had not been very far visible as a break, was a thin seam.

Mr. Kirkup said that he referred to seams up to 4 feet in thickness.

Mr. Blackett said that it depended upon the elasticity of the overlying strata; in some instances the break would extend a long distance, and sometimes the strata would bend down to meet the thill-stone.

Prof. Henry Louis thought that Mr. Halbaum had attached too much importance to the end-thrust due to the radial convergence of the lines of gravity to a common centre; but he was otherwise, generally speaking, inclined to agree with his views. Some two or three years ago, in endeavouring to follow out a somewhat similar train of thought, he had tried whether it would be possible to give numerical values to the data required in order to study the subject fully, and it seemed to him that the only possible point of attack was the assumption that, if the whole of the coal were taken away instantaneously in a given area, the downward thrust induced in that area could not exceed the thrust that the coal was supporting when it was there. Accordingly, it seemed to him that the maximum possible thrust could be determined by ascertaining the resistance of the coal to crushing; and he, with that idea, searched for information on the point, but was unable to find any record of the resistance to crushing of coal. He had made a number of tests upon blocks of coal, 3 or 4 inches on the side, and the results were recorded in Table I. The experiments were difficult to make, and the results were not particularly reliable. They showed, however, that the soft coking-coals of Durham generally began to crush at a pressure somewhere about 0·20 to 0·30 ton per square inch, and crushed completely at about 0·40 ton per square inch; whereas hard steam-coals did not begin to crush much under 1½ tons per square inch, and crushed completely between 1¾ and 2 tons per square inch. Obviously, the last series of figures were high, and shewed at once that the suggested mode of investigation

possibly lead to a practical result. If it were true th[illegible] t
t of the roof was equal to the maximum that the co[illegible] l
pport, they would have to fill in the ground with pi[illegible]
withstand the pressure of the roof, as it was obviou[illegible] s
crushing-strength of steam-coal was greater than th[illegible] t
pit-prop.

BLE I.—Results of Experiments on the Resistance to Crushing of certain Coals.

Name of Colliery.	Name of Coal-seam.	Pressure per Square Inch. When Coal begins to crush	Pressure per Square Inch. When Coal crushes completely —
		Tons	Tons
elaw	?	0·80*	1·29
Do.	?	1·70*	2·84
Do.	?	1·50*	2·20
Do.	?	? †	1·46
Do.	?	1·30†	1·70
Do.	Three-Quarter	1·20†	1·40
Garesfield	Brockwell	0·20*	0·29
Do.	Do.	0·20*	0·30
Do.	Towneley	0·30†	0·53
Chopwell	Stone	0·45*	0·63
Do.	Five-Quarter	0·25*	0·39
Do.	Hutton	0·35*	0·51
Hunter Pit	Do.	0·20*	0·30
Do.	Little	0·75*	1·07
Do.	Do.	0·27*	0·47
Do.	Main	0·25†	0·31
Do.	Busty-bank, bottom ...	?	0·77
Do.	Three-Quarter	0·35*	0·59
Derwent	Busty-bank, top ...	0·25*	0·35
Do.	Do. bottom ...	0·20*	0·25
Do.	Towneley ? ...	0·22*	0·30
Westwood		0·25*	0·30
Cowdenbeath		1·40*	2·58

* Coal placed flat as in its bed. † Coal placed on edge.

The Chairman (Mr. W. C. Blackett) said that, before leavin[illegible] f
that train of thought, he might say that for another purpose alt[illegible] e
gether, namely, that of ascertaining what were the probabilitie[illegible] s
of damage to the surface, he worked on the same lines, a[illegible] l
found the figures most useful for that particular purpose.

Mr. J. P. Kirkup said that Mr. Halbaum's paper gave th[illegible] e
first attempts of which he knew to solve the question of draw, a
question of very great importance to practical men in cases of
surface-damage. In a recent case, assuming that the surveys
were correct, he thought that at a depth of 240 feet the draw

was about 66 feet. In another case, at a depth of about 600 feet, the draw was 180 to 200 feet. The subsidence of the surface was very small: in one case, simply an open crack, and this, to his mind, proved that the effect was due to draw and not to subsidence.

Mr. W. B. Wilson (Easington) said that Mr. Halbaum's paper was an exceedingly clever one, and was a wonderful display of the writer's talent for close and minute scientific investigation. At the same time a feeling of disappointment was felt at the lack of real practical information or advice to those who had the daily control of longwall workings. Whether or not it would be admitted by northcountrymen, he (Mr. Wilson) was unable to say, but, in his opinion, longwall work was not only more general, but also more successful in the southern and midland counties than it was in the two northern counties. The reason for this undoubtedly lay in the fact that the underground officials and workmen themselves in the southern counties had a much better knowledge of the proper control and management of roof than men in similar positions in the northern counties, arising from different underground conditions and customs. One of the greatest of these differences was the fact that in the southern counties, the coal-hewers or getters not only set and drew their own timber, but did their own ripping and packing, the latter being the most important feature. There might be three or more men in a bank or stall, the leading man (generally an intelligent pitman) would frequently do very little in the way of holing, getting or filling, but would devote the whole or greater part of his shift to drawing and resetting timber, and to building middle packwalls. There being no quarterly cavilling, this man might be in one gateway for two, three or four years, and in time he became most skilful in the management of the roof. He became able to tell whether he had too much or too little weight upon his coal-face, and then he altered his middle packwalls accordingly: considerable latitude being allowed to these men as to the position of the middle packwalls. Moreover, he had no county average wage staring him in the face, and was not afraid to earn 10, 20 or 30 per cent. above that average wage. It was, therefore, greatly to his interest to make his place yield well,

and he often became very clever in attaining this object. I
this manner a class of pitmen was produced who had no paralle
in the northern counties; and the underground officials were
of course, drawn from this class. While, in the north country
the deputy, the master-shifter and the coal-hewer, working i
a longwall-face, knew nothing about the proper weighting
the roof. It was, perhaps, unfair to expect that Mr. Halbau
should have given such information in his paper, but he (M
Wilson) was convinced that a better practical knowledge of the
matters would be of great benefit in the two northern countie

Mr. H. W. G. HALBAUM, replying to the discussion, wrote th
in order to economize space and to confine the discussion with
manageable limits, he would pass over minor points raised
Mr. Blackett, especially as they were practically in agreeme
on many of them. He noticed, however, that Mr. Blacke
appeared to be sceptical as to the possibility of lateral moveme
in the overlying strata. At a later stage, nevertheless, h
admitted the possibility of lateral movement in the coal onc
the seam was cut. But, perhaps he might also be reminde
that the first big fall into the goaf cut the overlying strata
Would Mr. Blackett allow the possibility of lateral movemen
to the coal at a depth of 600 feet, and deny the same possibilit
to the immediate roof-stratum at 599 feet? And if he admitte
it for the roof-stratum, would he deny it for the stratum nex
above? In short, where between the coal and the surface woul
he draw the horizontal plane of rigidity, remembering that th
friction retarding the lateral thrust was a continually decrea
ing quantity as he ascended from the seam of coal to the surfac
soil? That was one way of looking at it, and Mr. J. P. Kirkup
experience probably furnished further information on th
question. Mr. Blackett was scarcely consistent, as, in replyir
to Mr. J. P. Kirkup, he stated that a certain contingen
depended on the elasticity of the overlying strata. B
if Mr. Blackett admitted elasticity, he could not consistent
deny possible compression in the virgin strata, nor actu
resilience in the broken strata, consequently, he could n
consistently deny the possibility of lateral movement wh
lateral freedom was effected. If it were objected that t
elasticity, the resilience and the lateral movement were sma

such an objection was not to the point. The point at issue was whether the small lateral movement developed sufficient energy to give rise to the phenomena described in the paper. And this energy was obtained, not by the weight of strata multiplied into the distance through which it actually moved, but by the weight of strata multiplied into the square of the velocity with which it moved. And some idea of the immensity of that velocity might be gained by remembering that the energy of the rebound was necessarily equal to the energy expended by the compressing forces, in so far as those forces were able to take advantage of the admitted elasticity of the strata.

Then with regard to the trend of the incipient or real planes of fracture Mr. Blackett stated that "no advantage, whatever, could be gained by comparing the break of the strata, due to subsidence, to the hade of a fault, and Mr. Halbaum got on to unfortunate ground when he suggested that the line of such a break could take an oblique direction over and towards the solid; and he was self-contradictory when he at the same time spoke of a cantilever over the face of work." Now these were three assertions flatly contradicting the propositions advanced by the writer; and Mr. Blackett supported them by no evidence. He (Mr. Halbaum), in taking opposite ground, had very explicitly stated his reasons for doing so, and it was not sufficient for Mr. Blackett simply to deny, he ought to have given some reason for doing so.

In conclusion, he (Mr. Halbaum) would offer a suggestion as to the direction in which the discussion might develop the maximum of profit. Suppose that a certain theory were submitted for discussion: then the writer held that the absolute truth of that theory was a question of but secondary importance. The prime questions were: Does the theory explain and account for the phenomena? Does it enable one in any measure to predict what will happen under certain circumstances? If the theory did not do that, it was useless as a working theory, however much of truth it might incidentally contain; but if the theory did explain and account for the manifestations, it was a valuable working theory, whether its premises were true or false: it was a scientific hypothesis, although destitute of absolute proof. A very cursory examination of the accepted working theories of matter and force would show that very few of

them were capable of absolute demonstration; and any theory of roof-action must necessarily fall into that class. The solid strata above the coal, and the seething goaf behind, were arenas of action into which they were unable to enter except by imagination. But he thought it not impossible that, by continuous and united labour, they might arrive at a working hypothesis which should account for the visible facts and even enable them to predict many of the phenomena. He invited members to examine the theory of his paper on those lines; and so far, Mr. J. P. Kirkup appeared to be the only one who had approached the case in that way. He appeared to be the only one who had compared the theory with the facts and phenomena that lay ready to his hand; and, curiously enough, he appeared to be the only one who had managed to extract a solitary crumb of hope or comfort from the theory.

The further discussion of the paper was adjourned.

Mr. E. O. Forster Brown read the following paper on "A Method of Packing Excavations in Coal-seams by means of Water":—

A METHOD OF PACKING EXCAVATIONS IN COAL-SEAMS BY MEANS OF WATER.

By E. O. FORSTER BROWN.

A process has been employed for some time in America, for supporting the surface under which coal-pillars have been robbed, the material being carried downward through bore-holes into the excavations by water; and, in the course of the last 4 years, the process has been introduced with considerable success into the working of coal-seams in Germany as an actual part of the system of working.

In Silesia, the seams at present chiefly worked are very thick, the sections of the three thickest averaging respectively, 10, 20 and 33 feet. They are as a rule flat or dip only slightly, but their thickness and a tendency to spontaneous combustion, until the past 4 years, presented serious difficulties to their successful working. The then system of working was pillar-and-stall, pillars being formed to the boundary and then gradually taken out back towards the shaft, the roof being allowed to fall as the pillars were removed. Some of the disadvantages attendant on this system were as follows:—(1) A large quantity of coal was lost in the broken. (2) Owing to a certain quantity of fresh air playing on this coal, it heated, and places in the broken had continually to be closed temporarily owing to danger from fire. This entailed having wide spread-out districts, with almost double the number of working-places necessary to maintain the output, and to employ the men who were continually being changed from one place to another. (3) The pressure on the places in the broken was very heavy, causing a large quantity of timber to be lost and numerous accidents. (4) The surface was seriously damaged by subsidence.

The best remedy for these evils, without changing the system of working, is an efficient method of packing the empty spaces left by removing the coal-pillars; and at the same time doing this without incurring too great expense. Hand-packing in the

majority of cases is too expensive, costing under the most favourable conditions 1s. to 1s. 6d. per ton of coal worked, and in addition, it is very inefficient: the best packing, so fas as can be ascertained from experiments, probably not occupying eventually more than 60 per cent. of the space originally occupied by the excavated coal. To meet the conditions successfully, the process already mentioned, with slight modifications, was tried, and for want of a suitable English equivalent, will be referred to hereafter by its German name *Spülversatz*.

FIG. 12.—DELIVERY OF THE MIXTURE OF SAND AND WATER INTO THE EXCAVATION.

Spülversatz consists of conveying underground, through pipes, in suspension in water, fine-grained material, and of depositing it where required; while the water filters away to clearing tanks whence it is pumped to the surface. The material need not all be very fine, but should be fine enough to act as a

matrix to the larger pieces. The material chiefly employed is sand, most of the lower ground of the Silesian coal-field being covered with sand to a depth of many feet; in addition, granulated blast-furnace slag, clay, dust-coal, cinders, ashes, refuse from coal-washeries and ground bricks or stone, are used more or less successfully. The material, however, should be as little porous as practicable, so as to avoid shrinkage on drying. The quantity of water required to convey the different materials to their destination varies, being dependent on the vertical depth, the number of turns in the pipes, the distance that the pipes are led underground, etc. Sand requires, as a rule, 1 to 1½ times its own volume of water, and dust-coal scarcely as much, while clay, cinders, etc., require 2 to 2½ times and sometimes more. At Myslowitz colliery, where spülversatz was originally introduced, 70,000 cubic feet, (2,000 cubic metres) of sand are carried down two pipes from the surface by water per day; and at Donnersmarckhütte colliery, 20,000 cubic feet (600 cubic metres) of mixed sand and granulated slag are run down one pipe.

The sand is won in different ways, according to whether it lies to the rise or dip of the pits. When it lies to the rise, a trench is dug at a slight inclination from the pit-mouth, and the sand is sprayed down into the trench with hoses and water at a high pressure: if slag or other material is to be mixed with the sand, it is tipped in the neighbourhood of the trench and sprayed down also, the mixture flowing to the pit and into a funnel fixed at the top of the pipes. When the sand lies to the dip of the shaft, it is filled into wagons by hand-labour, or latterly by steam or electrically-driven quarrying-machines; and the wagons are taken to the pit, and tipped into the mouth of the funnel. Another method is to drive a shallow heading at a rising inclination from the pit, and to spray down the sand from the end of it.

The funnels, into which the material is tipped, vary with the character of the material, the main point being to prevent the funnel or pipes from becoming choked: for ordinary sand or granulated slag, the arrangement shown in Figs. 1, 2, 3 and 4 (Plate VIII.) has been successfully employed, the sand is tipped in at the top and falls on to the grating C, gradually working through it, helped by the water sprayed on to it from A, through three rows of 80 holes, B, $\frac{1}{6}$ inch in diameter placed

round the periphery; to prevent choking below in the curve-pipe, D, and to get the mixture fairly started, the pipe, E, furnishes additional water-sprays. Clayey material is more apt to become choked, and is accordingly more difficult to use. An arrangement used for mixed sand and clayey material, is shown in Figs. 5, 6 and 7 (Plate VIII.): the grating consists of a series of horizontal shafts, carrying S-shaped knives, M, the shafts are made to revolve continually, and the knives cut up the clayey material into small pieces which drop downward, water being added from above during the operation; but the major portion of the water is added afterwards by the pipes, R. Fig. 8 (Plate VIII.), illustrates an arrangement where clayey material only is used; in this case, the clay is as far as possible disintegrated by means of water, before reaching the grating, and a large quantity of water is further sprayed against the under side of the grating to complete the disintegration of any large pieces lying upon it. It is preferable to work the water-spray at a pressure of several atmospheres, especially where clayey material is used; but this is not absolutely essential.

The question of the best kind of pipes to employ for conveying the mixture underground, experience has hardly yet had time to decide; wrought-iron and cast-iron are both used. The curve-pipes wear rapidly and are sometimes made of cast-steel thickened on the under side, and, at Myslowitz colliery, they last from 3 to 4 months. The horizontal pipes naturally wear most on the under side and are given a quarter turn, every now and then so as to get the longest use out of them; at Myslowitz colliery, the horizontal pipes stood 1½ years before being turned. The limit of horizontal transport of the material can scarcely be fixed, as it must be influenced by a variety of causes, including the character of material, quantity of water used, vertical depths from funnel, number of curves in pipes, etc. At Myslowitz colliery, the sand is carried 720 feet (220 metres) vertically and 1,650 feet (500 metres) horizontally; at Hedwigswunsch colliery, 650 feet (200 metres) vertically and 3,300 feet (1,000 metres) horizontally; and it is proposed to extend the pipes at both collieries considerably further in a horizontal direction.

At the space to be packed underground, the delivery-pipe is raised as close to the roof as practicable at the upper end of the open space, and the openings, except that for the delivery-

ipe, are closed by dams. Water, alone, is then allowed to flow ırough the pipes for some time so as to clear them thoroughly, nd afterwards the tipping of material at the surface is com- ıenced. The water, after depositing its load, filters away ırough a dam placed at the bottom end of the pillar, eventually :aching the clearing-tanks, whence it is pumped to the surface. Ieanwhile, the material is gradually depositing and being ghtened by its own weight, until only the small space round he mouth of the delivery-pipe remains unfilled; the flow is

FIG. 13.—WOODEN DAM, THROUGH WHICH THE WATER FLOWS AFTER DEPOSITING THE SAND.

hen turned off in this direction, and the same operation repeated ·ith it by means of branch-pipes, somewhere else. It is advis- ble to have telephonic-communication between the tipping- and elivery-ends of the pipes. After giving the packing a day or wo to dry, the dams are removed, and the coal in the neigh- ourhood can be worked: the packing remains quite tight and rm, and resembles a natural stratified bed.

The method of working the pillars at the Myslowitz colliery y this process is illustrated in Fig. 9 (Plate IX.). A portion, *bcd*, of the lowest pillar, I., is first taken out; dams are then rected at *bg* and *hi*; material is then delivered by the pipe-

main at *bg*, and the whole area, *agik*, is tightly packed. The major portion of the adjoining pillar, II., is then removed, and the remainder of pillar I., this space being filled, in its turn, as before; and so on with the other pillars, in the order of the Roman numerals. The dams are withdrawn and used again, as required, the water flowing away in the direction shown by the arrows. The dams are made of wooden uprights, with planks nailed across, and the interstices are filled with hay or bratticecloth, the uprights being usually supported by struts, which are especially necessary where the seam has a heavy dip, as the lower dams then carry a large proportion of the weight of the packing.

FIG. 14.—THE SAND, AFTER DRYING.

When slag or sand is used, the water reaches the clearing-tanks fairly clear, and does not injure the pumps: with clayey material, however, there is more difficulty in getting it clear, and the life of ordinary plunger-pumps is no doubt shortened. Possibly, the more general adoption of centrifugal pumps, with renewable casings, will help to overcome this difficulty.

The results of the adoption of spülversatz in Silesia, have, so far, been very satisfactory, and the majority of collieries with suit-

able material near at hand are beginning to try the process. The chief advantages to successful working, in making a comparison with no packing at all, are:—(1) All the coal is recovered, (2) dangers from spontaneous combustion are practically nullified, (3) pressure on pillars being taken out is reduced, and in consequence the risk of accidents is minimized, more timber is recovered and less crushed coal is produced, and (4) damage to the surface is avoided, so far as can be at present ascertained. Comparing the process with hand-packing, it is very much more efficient; where good material is used it occupies finally at least 90 per cent. of the space occupied by the original coal-seam; it is less costly; and material useless for hand-packing can be suitably used for spülversatz.

The chief disadvantages are:—(1) The water damages the pit-pumps, and (2) there may be stoppages of the water-supply at the surface during the winter. The first disadvantage may be avoided by pumping the pit-water separately.

Indirectly, there are other advantages: it makes no difference which of a series of seams is worked first, in so far as subsidence and pressure are concerned; the absence of danger from spontaneous combustion renders a much more economical concentration of the working-places possible, as spare places for men are not necessary to so large an extent; and the output per hewer is greater.

The cost of the process is not heavy, in consideration of the advantages accruing from it. At Myslowitz colliery, where the sand is filled into wagons by an electric quarrying-machine, and these drawn by electric locomotives, 1,000 to 1,200 feet to the mouth of the pipes, the total cost of the spülversatz varies from 5½d. to 6d. per ton of coal won by the process: this cost includes pumping, cost of new tube-pipes, interest on capital, depreciation-charges, in fact everything connected with the process, except the sand and water, which are free. The saving, resulting from reduced timber-cost and increased output per hewer, alone reduces this cost down to 2½d. per ton, which is more than outbalanced by the other advantages enumerated. The average cost of spülversatz in Silesia approximately averages 8d. to 9d. per ton of coal won by the process. At collieries where clayey material is used, the increased quantity of water used, of course, considerably enhances the cost, by extra pumping required.

The conditions prevailing in the Silesian coal-field, namely:—Thick seams liable to spontaneous combustion, and quantities of sand in the neighbourhood of most of the pits, make the adoption of spülversatz especially advantageous to general working; but the efficiency of this method of packing, in supporting the surface and enabling safety-pillars for the protection of surface-buildings to be removed, renders the process valuable under certain conditions in other coal-fields. In Silesia, safety-pillars are being taken out at very moderate depths, under buildings and railways, and the process is commencing to be adopted chiefly for this purpose in Westphalia.

The conditions in Westphalia are very different, the seams in general being thin and steep with poor tops; but these conditions are not disadvantageous to spülversatz, except that pillar-and-stall working is unsuited for them. The steeper the seams are, the tighter the material packs itself; the chief difficulty, however, is the want of material, there being no quantity of sand within reasonable distance.

At the Krupp-Sälzer-Neuack colliery, boiler-cinders are used. The present method of working is shown in Fig. 10 (Plate IX.). The seam dips 20 degrees, and is thin. The coal is taken off in lifts along the strike: the dotted line shows the inflow-pipe carrying water and material, and the arrows the direction in which the water flows after depositing the material behind the face. In this particular case, the inflow-pipes are raised a few feet before delivery; this is due to the workings not yet having had time to be adapted to the process. Fig. 11 (Plate IX.) illustrates the proposed arrangements of working for carrying out the system in the future. The mixture of water and material is kept back from the face by a palisading of posts, planks and brattice-cloth, *b*, put up 3 feet (1 metre) behind the face; and, as soon as the material is dry, the palisading is removed and replaced further inbye. The water drains through the palisading during the operation of filling, and flows away to the bottom-level. At this colliery, the material is not tipped into the pipes at the surface, but is taken underground to one of the upper levels in tubs and hauled to a staple-pit, near where it is required, and there tipped. The somewhat high cost of the process (1s. per ton of coal won) is chiefly due to the cinders and slag being

screened by hand, and the long distance that the material is hauled underground. The material is not the most suitable for the purpose, as it shrinks slightly on drying, and eventually is not expected to occupy more than 80 per cent. of the space originally occupied by the coal. This defect, however, would fully justify its introduction as a means of protecting surface-buildings from damage due to subsidence, being much more efficient and cheaper than hand-packing, which was originally tried and cost 1s. 8d. per ton of coal won.

At the Deutscher-Kaiser colliery, Neumühl, in the same coal-field, the operation is carried out on much the same lines as at Krupp-Sälzer-Neuack colliery. In this case, the seam is about 4 feet (1¼ metres) thick, and dips at 18 degrees. The material is granulated blast-furnace slag, brought by rail 3¾ miles (6 kilometres) from blast-furnaces belonging to the colliery-company. As at Krupp-Sälzer-Neuack colliery, the material is not tipped direct from the surface, but is taken underground and hauled some distance to a staple-pit, and there tipped. The actual packing takes place between depths of 1,200 and 1,550 feet (370 and 470 metres) below the surface. The present results of the process, which has been tried for about 1½ years, shew that it costs slightly less than hand-packing, eventuates in a saving of timber, and, up to the present time, the workings have not affected the surface, the better protection of surface-buildings being the chief reason for its introduction.

Taking coal-fields in general, and the North of England in particular, wherever safety-pillars, in any number, are at present being left for the support of buildings, railways or portions of surface, in cases where supporting the original surface from below would be more convenient and practicable than the replacement of the subsided surface aboveground, this process might be worthy of trial. The conditions would be especially favourable for its adoption where the best seams at a colliery, save the safety-pillars left, are worked out, and the present workings are at a considerable distance from the shaft. The cost of applying the process, under such conditions, would probably be more than compensated for by the higher selling-price of the coal won and the probable cheaper underground haulage of that coal. The difficulty would be in getting a sufficient quantity of suitable material: although old waste-

heaps, cinders, the dredgings from harbours and rivers (althou
the efficiency of the latter would have to be proved), an
at coking collieries, the washery-refuse would be availab
The process might possibly be worth trying where the be
material is available, for replacing shaft-pillars in distri
where the pressure is heavy and the cost of opening out fro
the shaft-pillar, in consequence, great. There are doubtle
other conditions, under which a moderately cheap yet efficie
method of packing would be of value.

It occurred to the writer that a description of the proce
might be of interest, in a district where the seams of coal are t
a large extent worked by bord-and-pillar; as the process afford
a practicable method of removing pillars of coal, hæmatite, etc.
without damaging the surface to the extent usually anticipate
with other methods of support, and at less cost.

The credit of originally introducing the process into German
and adapting it to suit the conditions prevailing there is due t
Mr. Williger, the managing-director of the Kattowitz Collier
Company, to whom the writer is indebted for much courte
and kindness during his recent visit to that district.

Mr. J. H. MERIVALE said that if the method described in the paper had been a theoretical one he would have said that *it* was unlikely to answer in practice, but the paper contained a description of a method carried out with practical success, both in America and in Germany. One point, not explained, seemed to present a great difficulty, and that was the clearing of the water by allowing it to stand in settling-ponds. It seemed to him (Mr. Merivale) that the settling-ponds would have to be of considerable size, and that they would require to be continually cleaned out.

Mr. A. L. STEAVENSON said that in Cleveland, about 30 feet above the ironstone seam, an exceedingly bituminous shale occurred, and when it fell into the goaf it heated, and, in some instances, took fire. The method described was worth considering in such cases. The great difficulty that he foresaw in the case of coal-working was the cost of the method. Surface-damages in this district rarely exceeded a few pounds per acre, and it would take many pounds per acre to fill up the workings by

this method. It would add considerably to the pumping costs, and in some instances it was as much as they could do already to find money to pump the water out of the pits. In the case of mining under towns, where the surface-damages were serious, it would be worth trying to see whether the system would do all that was expected of it.

Prof. Henry Louis asked what was the height of the sand-packs when they were formed, as it seemed to him that an open space of some inches would be left between the sand-pack and the roof, before any settlement of the ground took place. The process had been first introduced successfully in America in connection with the working of some of the anthracite-seams, the fines and refuse from the screenings being sluiced into the workings. He thought that "sluice-packing," which was a literal translation, would be preferable to the German word "Spülversatz."

Mr. J. B. Atkinson (H.M. Inspector of Mines) suggested that the process might be tried in some of the hæmatite-mines of Cumberland and Lancashire. At the present time, these mines caused considerable surface-damage, and if this system could be adopted it might result in more efficient working, and possibly altogether stop surface-damage. The method might also be tried in the oil-shale mines of Scotland, where the spent shale lay in great heaps ready at hand to be sent into the mines. In coal-mines, the process would probably be too costly unless the support of the ground was of considerable importance; but at collieries in the neighbourhood of towns, the process might enable the pillars of coal to be removed. In most cases, great difficulty would be experienced in getting material to fill the place of the coal.

Mr. T. E. Forster said that he had seen a hæmatite-mine in this country partly packed with sand—accidentally, through sand breaking in from the sea. He did not see how the sand could be packed so as to reach the roof; it could not support the roof, as though the coal had not been removed; it might minimize the subsidence, but it could not do away with it altogether.

The Chairman (Mr. W. C. Blackett) said that if 1,000 tons of coal per day were taken out of the mine, it would have to be

replaced by about 1,000 tons of sand, and a very large quantity of water would have to be pumped. It might be economical to avoid damage to buildings, but if it were only going to save land, as much land would be wasted as was saved. It would be impossible to get material in such quantities in the neighbourhood of most British collieries. The other materials mentioned, such as ashes from the colliery-boilers, etc., were only produced in very small quantities.

Mr. C. C. Leach asked what was the output per day at the collieries where the method had been adopted in Germany, and whether pillars were left to support the shafts.

Mr. H. F. Bulman (Burnopfield) wrote that it is perhaps worth mentioning that sometimes water alone, without any solid material, may be usefully applied to fill up goaves in order to prevent surface-subsidence. This is done at some British collieries in working a seam, by retreating longwall, uphill from a boundary formed by a big fault, forming a water-tight barrier.

According to accounts of German practice, which have appeared from time to time in the mining papers, instead of bringing the water from the surface, underground feeders have sometimes been utilized for flushing purposes. The solid material is taken down in tubs to an underground level, where the water has been collected in a reservoir, and where the flushing hopper is placed for conveying the material to the workings situated at a lower level.

The process has been successfully applied to filling up spaces above brick-arching, built to support a road which has fallen a long way up; and also to stowing lengths of old road, where the pressure was very great, preparatory to the removal of pillars. It has been stated, by the manager of a German colliery, where the system is in use, that 27 per cent. more material can be sprayed into the same space than by hand-packing. If the cost does not exceed 2½d. or 3d. a ton, there seems to be room for the process, especially in enabling all the coal to be got under valuable surface-property.

Mr. J. B. Atkinson (H.M. Inspector of Mines) moved a vote of thanks to Mr. Forster Brown for bringing to the notice of the members a method which had actually been accomplished in Germany.

The CHAIRMAN (Mr. W. C. Blackett) seconded the vote of thanks, which was cordially approved.

Mr. E. O. FORSTER BROWN, in acknowledging the vote of thanks, stated with regard to the clearing-tanks, that the majority of the collieries were using sand and that the water came out practically clear. In cases where clay was used, he understood that there were two or more sumps at the pit-bottom, which were filled and cleared alternately. Very little space was left above the sand when filling with the pipe, as the coal-pillars were always worked from the dip, the spaces were filled from the top-end, and, as a rule, only a small space was left round the mouth of the delivery-pipe after the process was completed. The process had only been in use for about 2 years, and it might take longer to prove the solidity of the packs. The enormous quantity of material necessary, and, in the majority of cases, not available in this country, had been mentioned, but of course it was only expected that the process would be applied in special cases. For instance, where the best seam at a colliery was exhausted, with the exception of a large number of safety-pillars, under valuable surface, it would probably pay to apply this process to remove these pillars, and washery-refuse or blast-furnace slag could be accumulated until they had sufficient for the purpose. So far as he knew, no shaft-pillars had yet been removed by this process. Where it had been applied, the outputs varied up to 1,000 tons per day from one shaft.

Dr. G. P. LISHMAN's "Notes on Safety-lamp Oils" were read as follows:—

NOTES ON SAFETY-LAMP OILS.

By Dr. G. P. LISHMAN.

ace numerous more or less expensive "patent safety-lam
are on the market, it may be pertinent to enquire:—(1
hat, specially, a good safety-lamp oil consists? and (2
at ought such an oil to cost?

(1) The patent safety-lamp oils consist of mixtures of fatt
nerally vegetable) oil with varying proportions of what i
own as "mineral colza." This latter has the appearance o
dinary paraffin oil, but has in reality nothing whatever to d
ith it. It has a much higher flash-point,* commonly fro
240° to 260° Fahr., whereas paraffin oil flashes between 73° an
120° Fahr. It is clear, therefore, that mineral colza is no
merely a refined form of paraffin, but is a totally different frac
tion of the distillate from petroleum, coming over, as it does
quite shortly before the lubricating oil. Finally, its specifi
gravity is 0·830, as against the 0·800 or so of paraffin oil. Th
flash-points of patent safety-lamp oils vary from 250° to 290
Fahr.: 270° is a very common figure for them. Mineral colz
mixes readily with fatty oils in all proportions, and there is n
special art whatever in "blending."

Several oils have been tested, as to their burning qualitie
in an ordinary safety-lamp burner. After numerous exper
ments it was concluded that, for purposes of distinction betwe
various oils, the best method was to load several safety-lan
bottoms with 50 grammes (about 2 ounces) of oil, and to bu
them in a photometer for 6 hours, altering or snuffing the wic
as required to maintain a constant light of 0·4 candlepow
The residual oil is weighed, the difference between this weig
and 50 grammes being the weight of oil consumed. The l
oil burnt and the less the attention required by the wicks, the
better the oil. About 6 inches of dried wick was used in
every case.

* All flash-points in this paper have been taken by the Pensky-Martens close test.

ae method of testing being settled, it was applied to various
In six experiments with a patent safety-lamp oil, 20·7, 20·7,
20·8, 20·9 and 21·7 grammes of oil, respectively, were burnt;
erage being 20·96 grammes. The wicks required very little
ion, being snuffed, perhaps, once each. The residual oil
out green, except in one lamp. Pure colza oil was then
the lamps burnt very badly, requiring constant attention
intain the light, and it hardly was kept up. The weight of oil
med was 22·8 grammes. These experiments on rape oil
afterwards repeated and confirmed. Cottonseed oil, if
perfectly liquid to begin with by warming, gave similar
s, the consumption being 22·3 grammes. The wick tends
ome somewhat cindery at the cap, with all the samples of
seed oil that the writer has tried. Nigerseed oil did
ly better, but seal and whale oil were no better. On the
, in no case did any one fatty oil show a material advantage
others in illuminating power, the selection, therefore, of
y oil for use is mainly a question of price.

ext were tested several samples of Scottish and American
al oils. The best was found to be American mineral
flashing at 250° Fahr. This oil burnt splendidly with a
ick, and all through the 6 hours' test, it was inclined to
instead of down, no doubt owing to the gradual warming
oil; most of the time the lamps were above 0·4 candlepower.
veight of oil consumed was 18·7 grammes.

The conclusion to be drawn from these experiments is
nineral oil, provided the right one is obtained, is a much
illuminant than vegetable or other fatty oils, and it is,
rse, a good deal cheaper. Dealers in patent safety-lamp
ometimes say that if mineral colza is used alone, a larger
ity is consumed; but that this is not so is proved by the last
iment recorded above, and by very many others.

ere are, perhaps, pits into which it would not be safe to in-
e an oil flashing at 250° Fahr.; and, on the other hand, there
any others where patent safety-lamp oil flashing at 270°
, might advantageously be replaced by mineral colza flashing
0° Fahr. In such cases the following points need to be
led to:—(1) The wick should be made of solid cotton instead
ing tubular; and (2) the wick-pipe should be about $1\frac{3}{4}$
s long instead of $1\frac{1}{4}$ inches, as is usual, where there is a

ture of fatty oil. With the ordinary burner, lamps burning neral colza are liable to be jerked out, since the wick must oject so very little above the top of the burner; the closer ting tube of extra length prevents this, and also takes the flame rther away from the oil-reservoir, so that the latter does not ecome heated to the same extent; this neutralizes, too, any ossible effect from the lower flash-point of the oil.

Mineral colza is not inflammable until heated to 300° Fah It can be obtained flashing as high as 262° Fahr., but the flam from oil of this flash-point is liable to be smoky in safety-lamps and where a flash-point higher than 252° Fahr. is essential, it better obtained by the addition of fatty oil. The mineral col flashing at 252° Fahr. is the best product for use in safety-lamps either by itself or in mixtures. Several mixtures with pure fat oils were tested, with cottonseed oil, for example:—(1) A 50 p cent. mineral-colza mixture burnt fairly well; (2) a 66 per ce mineral-colza mixture burnt well; and (3) a 75 per cent. miner colza mixture burnt very well. This last mixture flashes 256° Fahr., 19·1 grammes of oil being burnt per lamp in the hours' test. This mixture has also been found to work well practise. It is open, however, to two possible objections:—(1 The cottonseed oil is sometimes apt to cause a slight cinder the top of the wick; and (2), in frosty weather, it is liable to separate off stearin. These drawbacks have not been found serious, but both can be avoided if it is thought desirable to pay the extra price for rape oil. Taking the prices of these oils at:—Rapeseed, £23 per ton; cottonseed, £18 10s. per ton; and mineral colza, £ 0 per ton; and leaving out mixture (1) above as poor, the price per ton of No. 2 would be £12 16s. 8d.; and of No. 3 £12 2s. d. Except in those cases where a flash-point of 256° Fahr. is low, the latter, though the cheaper, is the better oil.

The CHAIRMAN (Mr. W. C. Blackett) moved a vote of thanks to Mr. Lishman for his interesting paper.

Mr. C. C. LEACH seconded the resolution, which was cordially approved.

Mr. J. T. BEARD's paper on "The Action, Influence and Control of the Roof in Longwall Working" was read as follows:—

THE ACTION, INFLUENCE AND CONTROL OF THE ROOF IN LONGWALL WORKING.

By J. T. BEARD.

The general proposition of extraction, confronting the miner, calls for the adoption of such ready means and methods as will permit of the safe and economical mining of the material forming the bed or deposit. Longwall mining, as its name implies, contemplates a continuous line of working-face, and the more or less complete extraction of the material forming the seam. Briefly stated, it is the only method in which all of the material is taken out in the first winning. No argument is therefore needed to place clearly before the mind the fact that the support of the roof in this system of working, and the control of its action or the movement set up in the overburden by the operation of mining, are features that demand the most careful consideration.

General Theory of Extraction.—In mining, the extraction of the material forming an underlying stratum presupposes the support of the overlying strata, by some means either natural or artificial, in order that the work of mining may be continued uninterruptedly. Otherwise, the unsupported material overlying the excavation will fall into the opening, in obedience to the law of gravity. The action of this weight or overburden of the seam is continuous and irresistible, producing what is called the roof-pressure. To support this great weight is a practical impossibility, and were it not for the over-arching of the roof-material, by which the weight is thrown on to the solid strata, forming the sides of the excavation, mining by any of the methods of the present day would be impossible. The natural over-arching of the material above an opening acts in the same manner as the roof-truss of a building by transferring the weight of the overburden or the roof-pressure to the solid strata. It occurs whenever an opening is driven in an underlying seam or stratum

leaving the roof-material unsupported, and is one of th principles of mining. It is illustrated by the clogging of a opening or door in the bottom of a bin filled with coa loose material, attempting to fall, jams and obstructs the ing. In the same manner, the unsupported roof-strata, fra by the superincumbent weight (Fig. 1, Plate X.), atte to fall, binds and jams, forming a natural arch abo opening.

Before proceeding, a few words explaining the gener and method of longwall working will assist to a better standing of the action of the roof, upon which the suc this method depends more than on any other feature. method of mining coal by longwall, the working-face is ad by taking out all the coal and allowing the roof to settl firmly on a uniform building of the waste of the seam, the miner. This waste consists of the rock, clay or slat ings, separating the several benches of the seam, and such of the roof-material as falls with the coal, and the un that is mined to permit the coal to fall. The waste, owin broken condition, has increased by about 60 per cent. original volume, and occupies, perhaps, 50 to 75 per c the original height of the seam, according to its quantity, arrangement of the packs, as they are called. When the are well built and cover a sufficient area, they are com by from 25 to 50 per cent. of their original height by the coming upon them. Roadways are kept open to the substantial road-packs built on each side, and by takin roof (brushing) over the roads, or lifting bottom, or both weight of the roof is thus seen to bear more or less heavily coal-face as the extraction proceeds, and is utilized miner to break down the coal. It is the action, influen control of this weight that we are at present considerin it forms the most vital feature of longwall working.

The Action of the Roof.—The unsupported roof-strat an opening have been described as fractured and crevi the weight of the overlying material, and the over-arc this weight, that takes place, has also been briefly note this means, there are produced two practically distinct an or less separate masses of roof-material above the exc

The action of these two masses is quite different, and due regard must be had for each, in order that the work may be successfully conducted. An attempt is made in Fig. 1, (Plate X.) to represent these rock-masses and the over-arching of the material above the opening at a longwall-face. The height of the arch and the fracture of the roof-material will vary with the character of the strata and the amount and manner of stowing the waste, or of building the packs; but the practical effect is to divide the overburden into two parts, the underweight or fractured material, A, below the arch, and the overweight or solid strata, B, above the arch. The underweight rests on the face of the coal and on the timber, while the overweight sets back on the solid coal, from which it arches over and settles down firmly on the packs. This conception of the overweight and underweight assists the mind to a clear understanding of what may be termed the "travelling weight," in longwall mining. The travelling weight is simply the underweight, rolling forward as it were, on to the face of the coal as the work advances. As each new web of coal is mined and broken down, this weight is thrown further forward on the face, while the slow, uniform settlement of the overweight on the packs behind, keeps an even pace. This, in substance and theory, is the action of the roof in mining on the longwall plan.

The Influence of the Roof's Action.—The action of the roof, just described, exerts a powerful influence, both on the mining or under-cutting and the breaking-down of the coal. When the roof-pressure is properly controlled, the work of the miner, when under-cutting, is made comparatively easy; the coal at the face of the cut is fractured by the weight thrown forward upon it, and, at each stroke of the pick, frees itself readily from the solid. The under-cutting is thus performed in a much less time when the coal is properly weighted. It is important, however, to remember that the roof-pressure, if too great, will exert a harmful influence by crushing the coal, and at times may cause the roof to break off short at the face, thereby defeating the very purpose of this method. An accident of this kind is both annoying and troublesome, and may necessitate a considerable outlay before the conditions of a successful longwall can be again restored. Again, the influence of the action of the

o advance more rapidly in some places than in others. As lready explained, better results are usually obtained by advancng the face in sections, the face in each section being the rc of a smaller circle than that formed by the general outline f the entire face; and a heavy roof-pressure is by this means ocalized and more easily controlled. In order to preserve the roper line of the working-face, the most experienced and steady orkmen should be placed on the main and cross entries, while hose who are less experienced and steady are distributed along he face between them. Fig. 3 (Plate X.) shows that the main-entry men, A, carry a full face all the time. This is lso the case with the men stationed at the temporary-road heads, xcept as they approach a cross-entry and are cut-off, when they re on half-face for a portion of the time; the cross-entry men re alternately on full-face and half-face. These men carry a full-ace just before starting a new road, E, the length of the face eing indicated by the small dots. As soon as a new road is tarted, the cross-entry man divides his face with the new man, ach being then on half-face, which rapidly expands to full-face s the work progresses. At B, the cross-road is shown as pproaching the point where it cuts off the second working-lace on the cross-road, C. It will be observed that the road-man in C2, has lost half of his face, which has been cut off by he approach of the cross-road, B; he has, however, one loose-nd, which is toward the cross-road, and is thereby enabled to nine a larger amount of coal than he otherwise could. At C, the ross-road is shown as having cut off the roadway, D4, and this man is now starting C4. The cross-entry man, C, is thus left with a half-face, but a loose-end at his right, which enables him to advance more rapidly. The face is shown as being dvanced in sections, each cross-entry determining a new section, and each section forming the arc of a circle. In Fig. 3 (Plate X.), these sections do not appear as expanded and do not cover as many working-places as they would, were the cross-entries shown at their proper distance apart relative to the distance between the rooms. This also gives a sharper corner of projecting coal where the faces of two arcs or sections meet, but it illustrates more clearly the working of the system. It is of the utmost importance that the cross-entry man should always cut in ahead of the road man, in order to maintain a symmetrical line of face;

and for this reason all cross-entry men should be experienced and steady longwall men.

The systematic timbering of a longwall face is, if possible, of even greater importance than the maintenance of the uniformity of line previously mentioned. The posts should be set in rows, parallel to the general line of the working-face: they are also commonly arranged in rows perpendicular to the face, which, however, is not so important as that the several rows should be parallel to the face. In longwall work, the timber should never be staggered, as this will generally interfere with the uniform weighting of the coal at the face; timber so placed is also more readily crushed by the weight, and one cannot judge of the proper working of the roof so successfully as when the arrangement is uniform. The drawing of the timber is also rendered much easier and safer when a uniform system of timbering is adopted.

The writer has referred to the fracturing of the roof, as incidental to the extraction of the coal, and the consequent dividing of the overburden into two portions, the action of which is separate and distinct:—(1) An over-arching weight that is irresistible and that rests far back on the solid coal and on the gob-packs; (2) an underweight of fractured material, in part supported by the timbers, and in part resting on the face of the coal and on the packs behind the timbers. It is the action of the underweight that breaks the coal. The regular drawing of the back timbers next the packs, causes this weight to settle forward uniformly on the face of the coal. The underweight rolls forward with a wave-like motion, beneath the settling overweight, very much as a ball would be rolled about under an inverted dish. The action of both these weights can be controlled, in so far as to cause each to subserve its purpose. The settlement of the overweight is regulated by the proportion of packwalls to the entire area of extraction, and the manner of building the packs. A too rapid settlement of the overweight will cause the underweight to bind and throw too much weight on the coal-face, beside crushing the timbers. In such cases, the proportion of packwalls should be increased and the packs built more solidly. On the other hand, if the overweight settles too slowly, the progress of the underweight is retarded and the coal breaks slowly.

The distance between the timbers, and the number of rows

pend on the conditions of the seam, roof, floor, depth of
tc. Less timber throws more weight on the face of the
ile more timber decreases this weight. Excessive weight
on the face is evidenced by the increased hardness of
lerclay or mining dirt, and the nipping and crushing of
l, or the production of too much fine coal. This excessive
may be caused by too small a proportion of packs, or
hat are poorly built, allowing a too rapid settlement of
erweight, when the back timbers will show signs of
ing; or by attempting to support too great an under-
in other words, carrying too wide an area between the
nd the face. In the latter case, the timbers will not
he same signs of taking the weight as before. In this
is necessary to decrease the width between the packwalls
e working-face, or the packs must be more firmly built
e posts set closer together, using heavier timber and
g it tighter. When the coal breaks slowly, this is either
by too large a proportion of packs, or too much timber,
narrow a space between the packs and the face; in any
e remedies are evident.

this paper, which touches all too briefly upon a most
nt subject in mining, the writer has avoided, so far as
able, reference to such details as are not directly con-
with the action, influence or control of the roof.

C. C. LEACH moved a vote of thanks to Mr. Beard for
er.

J. P. KIRKUP seconded the resolution, which was
ly approved.

THE SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING.

HELD AT THE UNIVERSITY, BIRMINGHAM, JANUARY 16TH, 1905.

PROF. R. A. S. REDMAYNE, PRESIDENT, IN THE CHAIR.

The minutes of the last General Meeting and of Council Meetings were read and confirmed.

The following gentleman was elected:—

MEMBER—

Mr. HORACE D. POOLE, Coseley, Bilston.

Mr. L. HOLLAND read the following paper on "Problems of working Thick Coal in Deep Mines":—

ROBLEMS OF WORKING THICK COAL IN DEEP MINES.

By LAURENCE HOLLAND.

ıe problems of working coal at great depths in Great
in are requiring closer attention year by year, as the depth
ıich coal is being worked is gradually increasing. The
Coal Commission of 1866 had before them evidence of the
tions of working coal at a depth of 2,418 feet at Rosebridge
y, Lancashire, and at that time there were only 12 pits
ling a depth of 1,500 feet in Great Britain. The present
Commission on Coal-supplies have evidence of the con-
s experienced in working coal under a cover of 3,483 feet
ndleton colliery, Lancashire, so that mining operations
advanced 1,000 feet in depth; and there are now nearly
its working at a depth exceeding 1,500 feet, including 20
a cover exceeding 2,000 feet, in Great Britain. The
e of mining has advanced with the depth: there is no
ı to doubt that it will make further progress, and that
ds and means will be devised to cope with such fresh diffi-
s of temperature and pressure as may arise while the depth
ning continues to increase.

ıe evidence given before the Royal Commission on Coal-
ies shows that the rate of increase of the temperature of
rata appears to vary within wide limits in different parts
country. Some of the average rates of increase, calculated
observations made at different collieries, taking 50 degrees
invariable temperature at a depth of 50 feet, are given in
I.

rom Table I., it appears impossible to estimate, with any
e of accuracy, the anticipated temperature at a given
, but if each district be taken separately, the average rate
rease is 1° Fahr. in 64 feet for Lancashire, and 1° Fahr. in
et for North Staffordshire. The observations in South

shire show a very low rate of increase; but from two tions only, it is difficult to judge whether these rates apply generally throughout the district, or whether purely conditions have affected the observations in each case.

TABLE I.—TEMPERATURE-GRADIENTS IN LANCASHIRE AND STAFFORDSHIRE COLLIERIES.

County.	Colliery.	Rate per 1° Fahr. Feet.
Lancashire :	Rosebridge	55·0
	Abram	58·7
	Pendleton	62·0
	Agecroft	68·2
	Dukinfield	68·4
	Moss	73·0
Staffordshire, North :	Great Fenton	67·1
	Glebe	67·5
	Florence	68·4
	Sneyd	68·6
,, South :	Baggeridge	108·0
	Hamstead	110·0

Assuming that the temperature of the strata can be calculated for a certain depth, the working temperature of the seam, when opened out, would depend greatly on the nature of the coal and the conductivity of the surrounding strata. On the one hand, there are seams which, when opened out, are cooled down by the effect of a ventilating current; and, on the other hand, there are seams which are continually giving off heat to the air. The air gradually picks up this heat until a stage is reached when the air becomes warmer than the coal, and beyond this point it is impossible for the air to cool the working-places.

TABLE II.—THERMOMETRIC AND HYGROMETRIC OBSERVATIONS IN A THICK COAL-SEAM.

Place of Observation.	Distance travelled by Air from Pit-bottom.	Length of Time that Coal had been exposed.	Temperature of Coal in Bore-hole.	Temperature of Air.		Relative Humidity: Saturation being 100.
				Dry Bulb.	Wet Bulb.	
	Feet.		Degrees Fahr.	Degrees Fahr.	Degrees Fahr.	
Surface	—	—	—	39	35½	73
Pit-bottom	—	—	—	51	48	80
Main haulage-road ...	4,098	—	—	63	58½	77
Heading in coal ...	6,168	1 day	71	73½	73	97
Do. do. ...	6,210	1 ,,	71	73½	73	97
Gateroad	6,771	2 years	72	73	70½	89
Opening	7,080	2 ,,	74	77½	77	98

Table II. shows how the air takes up the heat and moisture in travelling through a thick coal-seam, and as it gets nearer

e working-places the coal begins to heat above the normal erature of 71° Fahr., and rises 3° in a distance of 870 feet. bore-holes were made in the middle of the coal-seam, and ɔet in from the face of the coal. The thermometer was ɔd in a bottle of water, and the end of the bore-hole was ɔed with clay; and the thermometer was kept in the hole bout 1 hour in each case. Table III. records the observa- made by Mr. W. N. Atkinson in August, 1902, in the district of the mine. The normal temperature of the from these observations is 71° Fahr., and the temperature ıe coal after 8 months' exposure in one case had risen

As the air passes onward through the workings, the tem- ture ranges from 80° to 86°, being highest in the sides- ork, which have been open for the longest time. It may be remarked that, as the air returns to the pit-bottom, it is d down by the rock-strata to 66° Fahr. at the upcast pit- m. The amount of moisture given off by this seam is very , and adds greatly to the discomfort of working. In a thin , with a rock floor and roof, the increase in temperature and oisture would not be so great, probably, because there would be half the surface of coal exposed in the roads.

TABLE III.—TEMPERATURE OF COAL AND AIR IN A THICK COAL-SEAM.

Place of Observation.	Distance travelled by Air from Pit-bottom.	Length of Time that Coal had been exposed.	Temperature of Coal in Bore-hole.	Temperature of Air.
	Feet.		Degrees Fahr.	Degrees Fahr.
Road at face	6,090	8 months*	72½	75
Do. do.	6,840	1 day	71½	75¼
Do. do.	6,300	,,	71	75

* Coal wet.

o add to the difficulty of thick-coal mining, the air, on reach- he openings, also loses its velocity, because the sectional area opening is generally from 60 to 70 times that of the horse- assuming a side-of-work to measure 84 feet in width and t in height. This air, which has already been heated, cannot the opening cool and sooner or later fire occurs, either in the coal or in the fallen "shut" or "gob," which is generally l with slack. This is the chief factor in determining the of the side-of-work in working thick coal by square work, s the depth increases the normal initial temperature of the

coal will be higher, and if special means are not taken to cool down the workings the area of the sides-of-work will be less. This will necessitate leaving more ribs, and an enhanced cost on account of the number of heads required to open off the sides-of-work. In consequence of this, a smaller percentage of the area of the mine will be taken out, and a larger percentage of slack will be made.

To meet the increasing difficulty of the heat, two methods suggest themselves:—(1) To increase the ventilation; and (2) to cool the air artificially. A greater ventilation would be obtained by increasing the ventilating power and the velocity of the air. This may meet the case in a seam, which is not subject to fires; but very probably in working the Thick coal-seam the higher water-gauge would create more coal-fires, which generally occur in breaks in the coal, where there is any obstruction to the air, such as the corner of a rib (where the air turns at right angles) or at the side of a brick-stopping in a bolt-hole, between the intake and return airways, or at such-like places. It would be preferable to increase the volume of air by providing larger shafts and larger intake and return airways. To put more intake airways into the coal-seam would be of no advantage, because they would afford extra surfaces of coal, from which the air would convey heat and moisture into the workings.

The objection at the present time to cooling the air, would be the cost. To cool the air to any appreciable extent would need large air-compressors, and the air would be passed into a condenser or condensers, surrounded by cooling jackets, before being conveyed in the pipes down the shaft. This air would be taken into each district of the mine and delivered in the roads before entering the sides-of-work. Compressed air, delivered systematically and blown through small pipes, would assist very materially in cooling the air, and would reduce the percentage of moisture in the air. The air on being blown out of the pipes would also induce a current of air, in the same way as air is set in motion by steam-jets, arranged in the upcast shaft. A somewhat similar system was tried on a small scale at Zwickau colliery, in Saxony, with good results.* The seam was thick,

* "Auxiliary Ventilation for Gassy Pits," by Mr. C. von Steindel, *Trans. N.E. Inst.*, 1884, vol. xxxiv., abs., page 3.

nd gave off gas in large quantities. A plant was erected apable of compressing 2,000 cubic feet of air per minute to a ressure of 44 pounds per square inch; and, on being liberated, he air would expand to a volume of about 6,000 cubic feet.

A vague idea only can be formed of the pressure to be anticiated at great depths. The nature of the overlying and underying strata influences the working of a coal-seam probably iore than the depth, and, by reason of this, there are many orkings at comparatively shallow depths where the pressure is s great, and in some cases greater than in workings at greater epths. A reasonable inference, however, may be drawn by omparing the pressure on seams being worked in the Cannock hase district at depths of 450 to 750 feet, with the same seams n the south side of the Walsall Wood and Aldridge fault, where the depth varies from 1,350 to 1,650 feet. Here, there re, within a small area, the same seams being worked by the ongwall method and holed by hand, and all other conditions are xactly similar except the depths. The weights on the faces, taken seam for seam, are only increased very slightly with the xtra depth, and the maintenance-cost of the roads is no more in the one case than in the other. Again, the collieries in the Rowley district, at a depth of 660 feet, and Sandwell Park colliery at a depth of 1,350 feet, are working the Thick coalseam in each case, and the crush on the roads and workings is, he writer believes, not appreciably more at Sandwell colliery han in the Rowley district collieries. These comparisons tend o show that the difficulties due to pressure do not increase in proportion to the depth. The result of taking out a seam of coal is the sinking of the beds and layers composing the overying strata, and as these sink a great strain or tension is placed n the lowest layers, causing them to break, then more strain is ut on the layers next above, causing them in turn to break and ubside on to the packs. As this strain travels upward, the ending strain on the rocks becomes less until a point is reached where the tension is comparatively small, and the rock is of a ufficiently tenacious nature to withstand it. From this point pwards, the superincumbent strata are bound together and end to support each other, and thus throw only a small portion of their weight upon the strata below. The pressure on the workings would thus appear to depend more upon

the nature of the strata overlying the coal-seam, than on the depth from the surface. How far above the seam, the workings may pull, can only be proved by working the upper seams if there are any. An interesting observation on this point is noted by Mr. T. E. Forster.* When the Yard seam was worked at a distance of 180 feet above the old workings of the Low Main seam, there was no appearance of disturbance due to these workings, and no downward disappearance of water from the workings in the Yard seam. There was a thick bed of sandstone between the two seams, which had evidently not been pulled by the workings in the Low Main seam.

In removing a coal-seam, 24 feet thick, the sinking of the roof will naturally pull to a greater extent than it would in a thin seam, and if there is not a very strong rock in the immediately overlying strata, a vibratory motion is set up in an immense mass of strata, the coal becomes crushed and makes a larger percentage of slack, and the heavy weights on the roads cause both roof and floor to give way. To work a thick coal-seam by the longwall method in two sections would tend to lessen this pressure to a certain extent, because (1) only half the thickness would be removed at a time; and (2) packs could be built to steady the weight. This method would also have the advantage of increasing the percentage of round coal in the top part of the coal-seam. Coal-cutting machines might be used, and would allow of a smaller length of working-face for the same output. On the other hand, suppose that the top seam was being worked first, if the roads pushed up, the "bating" would be done in the bottom coal, which would ruin the working of it afterwards, or the roads would have to be ripped in rock, which would add considerably to the cost. The working of the bottom coal afterwards is expensive both in actual getting and in timber. Whether this method of working would be more advantageous than square-work, seems to depend on the amount of coal which would be lost in the working of the bottom coal, with the possibility of comparatively large areas of it being cut off by fire, compared with the amount of coal lost in ribs and pillars, which in deep mining, probably, could not be recovered. Where there is a thick parting or a hard stone parting between

* "Undersea Coal of the Northumberland Coast," *Trans. Inst. M.E.*, 1902, vol. xxiv., page 426.

p and bottom coals, it would make a better roof and be avourable for the working of the bottom coal.

e tension of the Thick coal-seam would undoubtedly be d by working a thin seam either above or below it. It then make a larger percentage of round coal, and would ly reduce the liability to bumps, crush and fire. In the k Chase district, the Deep coal-seam, the lowest seam of the t, is generally worked before the Shallow seam, lying 60 ove it. The Shallow coal-seam is then found to be harder make a larger percentage of round coal, than where it is l in advance of the Deep coal-seam. At Hamstead r, where the Thick coal-seam has been worked under the in the Brooch coal-seam they stand without repair, but the Thick coal-seam is still under the roads, they are lifting.

is suggested that the New Mine coal-seam, occurring 90 feet below the Thick coal-seam, should be worked the longwall system to the boundary and the Thick coal- hen brought back towards the shaft. The writer is not of this method having been tried anywhere, and the Thick am is generally worked out first. If it is thought advisable k the Thick coal-seam first for commercial reasons or other- it would be advantageous to drive out the roads to the ary in the White ironstone, and then to get up into the coal-seam and work home. By driving in the White iron- the liability to fire would be reduced considerably, and roads could be driven out to increase the ventilation, t taking so much heat and moisture into the workings, ls in the coal would do. This system would also entail cost and delay in putting the pit to work.

per mining seems to point to increased cost generally, in g with higher temperatures and producing improved ven- a, and overcoming the tension in the case of the Thick am. The cost of sinking will naturally increase in pro- a to the depth. These extra costs will probably be met by an increased output and partly by improved nical appliances, such as high-pressure boilers, mechanical s, ash-conveyors, economizers and central condensing and, as the areas of shallow coal are getting smaller, the of deeper coal will become enhanced.

Mr. HENRY JOHNSON wrote that, although Sandwell and Hamstead sinkings had proved the Thick coal-seam in its entirety, subsequent workings at both collieries had proved a commencement of a splitting-up of the seam, eastward, in the direction of the Warwickshire coal-field. Therefore, with the wellfounded knowledge of a northward and southward and westward splitting-up of the seam (as already proved in the past working of the exposed South Staffordshire coal-field), it was reasonable to suppose that the deep-seated Thick coal-seam, as one seam, was of limited area. The difficulties attending the working of the seam where it was deepseated would therefore only apply to a limited area, or where the Thick coal-seam existed as one seam, or where it existed with increased thickness of partings. A seam of so great a thickness and under so great a superincumbent pressure should be opened out, with ample barriers between the main roads. The development and working of the seam should be conducted with a due regard to the distribution of the superincumbent pressure, and the unlocking of faults should be avoided as much as possible.

There could be no doubt that an era of deep mining had commenced in Great Britain, calling forth the most strenuous energies of the mining engineer, the mechanical engineer, the electrical engineer and the ventilation engineer. He (Mr. Johnson) ventured to predict that the two last-named would, in the near future, become very important and necessary permanent sub-officials in the working and conduct of deep mining in Great Britain. In that connection, he might mention that the time would seem to have arrived when a suggestion made by him (some 20 years ago) might now be usefully considered: to employ an official who would be held responsible for the provision of a constant and adequate and properly split and distributed ventilation at extensive collieries. The responsibility of such an official would extend from the top of the downcast-shaft to the top of the upcast-shaft, and include the supervision of the fan and the fan-engine.

The PRESIDENT (Prof. R. A. S. Redmayne) observed that the greatest difficulties of deep mining were those connected with the cooling of the air and the ventilation of the mine. The possibilities of the use of liquid air, for cooling the air, were worthy of

consideration and discussion. The problems facing them were such as called for the aid of the pure scientist to assist the applied scientist (the mining engineer), in devising some practical method of reducing the temperature of the air of the mine and an efficient means of dealing with its ventilation. Probably, the solution of the latter difficulty would be found in a system of sectional ventilation.

Mr. T. H. Bailey remarked that liquid air might be used both for cooling and hauling, thus superseding horses, a well-known source of heating the atmosphere of a mine. Liquid air was now produced commercially at about 4d. per pint, and its use would be quite safe.

Mr. A. W. Grazebrook remarked that the large area of coal exposed on the roof and sides of the roadways in working a thick seam, would account for much of the heat. The working of the Thick coal-seam in two sections had not proved a commercial success: the top coal was usually of good quality, but the bottom was inferior.

Mr. W. N. Atkinson (H.M. Inspector of Mines) said that, where the air was higher in temperature than that of the surrounding strata, there was some other cause at work, needing further investigation. The great area of coal exposed in working the Thick coal-seam did not seem, alone, capable of explaining the heating due to oxidation, which occurred in that seam; because in other seams, worked on the bord-and-pillar system, where vast surfaces of coal were exposed, such heating was often not observable. He (Mr. Atkinson) agreed with Mr. Holland that the pressure was not altogether due to depth, but to a great extent to factors other than depth.

Mr. W. Charlton referred to a paper by himself on "A Method of Working the Thick Coal-seam in Two Sections"* read on February 2nd, 1902. He thought that a committee might be appointed by the Council to collect all important and practical information available in the South Staffordshire district, bearing on the question of the working of the Thick

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 112.

am. He moved that the Council of this Institute be ted to appoint a committee, to investigate the methods of ng the Thick coal-seam of South Staffordshire and adjacent cts, under prevailing conditions.

Mr. T. H. BAILEY seconded the motion, which was agreed to.

Mr. S. L. THACKER said that when Prof. R. A. S. Redmayne's per on "The Training of a Mining Engineer" was discusse April, 1903, he (Mr. Thacker) expressed the opinion tha he Institution of Mining Engineers should establish examin ions for the qualification of membership.* The passing of th Coal-mines Regulation Act (1887) Amendment Act, 1903, ha not caused him to modify those views to any material exten and he emphatically agreed with the President that there w no sufficient reason why the professional status of members that Institution should be below that of members of the Insti tion of Civil Engineers.

He moved that the Council of the Institute should consi the advisability of communicating with the other federa societies, requesting their views on the important questions rai in Prof. R. A. S. Redmayne's "Presidential Address,"† m particularly in reference to the revision of the constitution The Institution of Mining Engineers.

Mr. T. H. BAILEY seconded the resolution, which was agreed to.

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* *Trans. Inst. M.E.*, 1903, vol. xxv., page 277.

† *Ibid.*, 1904, vol. xxviii., page 38.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.

GENERAL MEETING,

HELD IN THE ROOMS OF THE SOCIETY, QUEEN'S CHAMBERS, 5, JOHN DALTON STREET, MANCHESTER, ON NOVEMBER 8TH, 1904.

MR. JOHN GERRARD, PRESIDENT, IN THE CHAIR.

The following gentlemen were elected, having been previously nominated:—

HONORARY MEMBERS—

MR. HERBERT BOLTON, F.R.S.E., Curator and Secretary, The Museum and Reference Library, Bristol.

MR. MARK STIRRUP, F.G.S., High Thorn, Stamford Road, Bowden, Cheshire.

MEMBERS—

MR. RONALD GORDON GRANT, Electrical and Mechanical Engineer, British Power Company, 5, Great George Street, Westminster, London, S.W.

MR. H. P. HARRIS, Mining Engineer, Brynmally Collieries, Wrexham.

MR. WARWICK GREY HODGE, Electrical and Mechanical Engineer, Halford Park Road, Lytham.

MR. JOHN EDWARD LANDLESS, Manager, Habergham Colliery, Burnley.

MR. DANIEL MORRISON, Civil and Mining Engineer, 41, John Dalton Street, Manchester.

MR. MONTAGUE BROWN MOUNTAIN, Mechanical and Electrical Engineer, Redcliffe House, Barton-on-Irwell, Manchester.

MR. THOMAS POWER, Owner and Manager, Commons Colliery, The Commons, Thurles, Ireland.

MR. GEORGE G. K. PREECE, Mechanical and Electrical Engineer, 134, Russell Street, Moss Side, Manchester.

MR. CECIL SYDNEY RAMSDEN, Civil and Mining Engineer, 42, Deansgate, Manchester.

MR. HAROLD RIGBY, B.Sc., Mining Engineer, Greville Lodge, Winsford, Cheshire.

MR. WILLIAM YOUNG, Manager, Slievardagh Collieries, Ballynonty, Thurles, Ireland.

STUDENT—

MR. FREDERICK NORMAN TONG, Spring Bank, Astley Bridge, Bolton.

The PRESIDENT (Mr. John Gerrard) read the following "Presidential Address":—

PRESIDENTIAL ADDRESS.

By JOHN GERRARD, H.M. Inspector of Mines.

Colonel Hollingworth, in his inaugural address a year ag[o] ter alluding to the change in the title of the Society, said I hope it will take further steps with a view of being [in] eality the Mining Institute for Lancashire, Cheshire, and t[he] neighbourhood." One further step has been taken: we co[m]mence this Session conjoined with the other mining societ[ies] in England and Scotland as The Institution of Mini[ng] Engineers. We now stand in line with the 2,688 members that Institution, and upon any question that may be refer[red] our voices will be joined with theirs. We shall have the opp[or]tunity of meeting mining men from all parts. Our experien[ce] will be given to them, and theirs we shall receive. Last y[ear] 79 papers on mining and geology were circulated amongst t[he] members. We shall be enabled to read all such papers a[nd] any that it may be desired can be discussed by this Socie[ty.] Our individuality will be fully maintained, we shall have o[ur] own officers, our comfortable rooms, our excellent library, a[nd] the funds that we have accumulated will still be ours. No lon[ger] will the mining men of this coal-field have reason to forward su[b]scriptions to Scotland, Newcastle-upon-Tyne, Yorkshire, the M[id]land counties or Staffordshire. Is it not now their duty to support their own Society? May the hope be expressed th[at] during this coming year all will join us, and help to make the Society fully representative of this large and important coal-fie[ld.]

Within the Lancashire and Cheshire coal-field it is stated that there are 400 mines, giving employment to 95,000 persons and producing 25,000,000 tons of minerals. If we could induce our neighbours in North Wales to come to us, the number of mines would be increased to 463, with 108,000 persons employed, and 28,000,000 tons of minerals raised. These figures indicate that a large number of persons should be interested in "the

collection and diffusion of practical and theoretical knowledge respecting geology and mining." These were the objects desired when, in 1838, this Society was established. There can be no manner of doubt that implied therein was the further object to fully consider the prevention of accidents and loss of life in mining operations. Our records give proof of the excellent work done. It was in 1862 that the famous papers on the gases met with in coal-mines, the general principles of ventilation, and on the friction of air in mines, were read before this Society by Mr. John Job Atkinson, H.M. inspector of mines. Most of those prominently associated with mining, past and present, have freely contributed of their experience. Many names could be honourably mentioned, Messrs. William Peace, Andrew Knowles, Peter Higson, John Knowles and George C. Greenwell gave their full support; and one whom we all so much revere, who is stated to have started as a mining pupil so long ago as 1835, Mr. Joseph Dickinson, constant in his attendance, ever ready to draw upon his vast experience by contributing papers or joining in their discussion. Surely then, we may expect the mining men of Lancashire to follow these excellent examples.

With regard to geology, may we not appeal with confidence to those who have in the past done so much to extend its application, to continue the good work? The larger field, the contributions from other societies, we hope, will induce them to increase their interest and to extend their numbers. Probably no member of this Society more ardently represented geology than the late Mr. E. W. Binney. He is reported to have said in 1861, that "he had had hopes that the mining people of this district would have made this Society into something like a mining institute as well as a geological society," and now, after more than 40 years, Mr. Binney's hopes may be fulfilled. The opportunities afforded Mr. E. W. Binney, Prof. W. C. Williamson, Prof. W. Boyd Dawkins, Mr. Mark Stirrup, Mr. George Wild, and others, will be continued to their geological successors. We have been greatly gratified by the full support that Prof. W. Boyd Dawkins has given to the new movement. For 35 years he has been our geological mainstay, ever willing to help, delighted to display and describe the

ections at the Museum of the Manchester University. Those
have visited other museums will agree that nowhere can
found a better collection of Coal-measure fossils, nowhere
tter stored, the order and facilities for viewing are perfect.
ancashire may well be proud of this Museum, the members o
he Society and all others interested in coal-mining should con-
tinue to support it and send there the best specimens found i
this coal-field.

There are many geological problems still unsolved, muc
geological work to be done. One of the most important question
affecting this district, upon which much depends, is that
the continuity of the Arley seam between Bolton and Ma-
chester. Several explorations have failed to find the sea
in other places the seam is practically worthless. There may
an area within which the Arley seam was less richly deposite
entirely wanting, or, possibly after deposition, denuded. T
change in the Arley seam from Wigan to St. Helens is w
known; at the latter place it is known as the Little Delph.
careful mapping of the proved explorations, and the collecti
of the records, should now be made. A valuable paper mig
be contributed on this subject.

The extension of the coal-field in a southerly direction shou
be carefully watched. The boring at Astley has revealed wh
may prove to be a considerable extent of Coal-measures abo
the Worsley Four-feet seam. The proposed sinkings at Astley
may enable a fuller examination to be made. The proving of
the Mountain mines in the Wigan district cannot be long
deferred. Then we shall know what changes have taken place
in the Mountain mines from crop to deep.

There is much to be done as regards correlating the seams
in the west and the east. Although there are many changes
in the character of the seams, and their relative distances apart
on the west side of Manchester the seams are well correlate
But on comparing the seams found to the east of Manches
with those to the west, great differences are seen, and practic
the problem is unsolved. The Mountain mines are cle
defined at Billinge on the extreme west, as at Littleborou
the extreme east. The Arley seam is at Rochdale, Heywoo
Burnley on the east, as at Westhoughton, Ince and Wi
the west.

For 60 years, geologists have been puzzled as to the identity f the coal-seams at Bradford, Manchester. The sinking of he new shaft to a depth a little short of 2,700 feet should help o clear the situation. The strata ought to be carefully examned and the fossils collected.

In North Staffordshire, several marine beds have been ocated in the Middle Coal-measures, and also in Derbyshire. n Lancashire, only one has been clearly defined, the one found y that excellent geologist, Mr. George Wild, at Ashton Moss olliery, said to be about 750 feet above the Great mine. If the reat mine corresponds to the Crumbouke or Ince Four-feet eam, that marine bed is high up in the Middle Coal-measures. n the table are several specimens of marine shells, *Orthoceras*, *ecten*, etc., found at Victoria colliery, Standish, probably ear to the Arley mine. This is clearly a second marine bed, nd careful examination of the strata near to the Arley mine ay lead to this bed being found in other places. On the able is a specimen of *Pecten*, found above the Black Shale or ilkstone seam in Derbyshire by Mr. Walcot Gibson.

From a mining point of view, the Lancashire coal-field has ssociated therewith three especial features: steep inclinations, hin seams and great depth.

The greatest inclination is probably at Moston colliery, anging from 40 degrees (in one place 51 degrees) to 20 degrees, r from 1 in 1¼ to 1 in 2¾. At a number of collieries, extendng from Ashton-under-Lyne to Pendleton and Clifton, and gain at St. Helens, the dip varies from 1 in 2½ to 1 in 3½. The nclination of the seams may be associated with the large faults hich traverse this coal-field, the Irwell valley fault having a hrow of 3,000 feet, and other faults of 1,800 feet, 1,500 feet nd 1,200 feet have been proved. It will be admitted that the orking of these steep seams involves greater difficulties and ncreased cost, and greater danger to the workers.

Probably in no coal-field, except Somerset, are thinner eams worked. Billinge, Bacup, Burnley, Accrington, Blackurn, Chorley, Rivington, Rochdale and Littleborough prouce coal from the Mountain-mine series, from seams less than foot to something over 2 feet thick.

At Pendleton colliery, coal is being worked at a depth of

3,483 feet from the surface, a greater depth than elsewhere in Great Britain. For some years coal was wound at Ashton Moss colliery a vertical distance of 2,820 feet, and is now being raised from a depth of 2,268 feet. At Bradford colliery, a shaft is being sunk to a depth of 2,670 feet. The depth to the Arley mine at the proposed Astley colliery will probably be 3,400 feet. It will readily be seen that if the Rams mine at Pendleton corresponds to the Furnace mine at Ince, the depth to the underlying seams will be very considerable. A valuable paper would be one which mapped the area of deep coal in Lancashire and gave detailed information as to the probable depths of the seams. It is rather odd that only one paper has been contributed to this Society on deep mining: in 1870, Mr. John Knowles gave a full account of the working at depth at Pendleton colliery.

Probably the most important factor in deep mining is that of temperature. The deeper we go into the earth, the higher is the temperature. The ratio of increase in Lancashire may be said to vary from 1° Fahr. in 60 feet, to 1° Fahr. in 80 feet. At Pendleton colliery, the highest ascertained temperature in the working faces approaches to 94° Fahr. The depth at the shaft is 1,545 feet; an engine-plane, driven along the line of dip, has already been carried 6,000 feet from the shaft, and further extension is possible. The dip is about 1 in 3½.

Personal observations in the deepest known coal-mine, situate in Belgium, have proved that at a depth of 3,773 feet from the surface the highest temperature is 104° Fahr. In this mine, as at Pendleton, the air is remarkably dry. In the Belgian colliery, the dry bulb registered 104° Fahr., the wet bulb 84° Fahr., or 38 per cent. of humidity only. In Pendleton colliery, the dry bulb registered 93·3° Fahr., the wet bulb 79·7° Fahr., or 49½ per cent. of humidity. So far, practically, that which has been depended upon to cool the high temperature of the strata is ventilation. At Pendleton, it is true that haulage-engines, worked by compressed air, discharge small volumes of cool air, but the effect has been proved to be purely local.

Upon two points connected with deep mining papers might be contributed:—The effect of large volumes of fire-damp

m a pronounced fiery seam, and the effect of
tion in coal-seams peculiarly liable to spontaneous

Upon these points it is interesting to find that in
. W. Binney, in a paper contributed to the Man-
ogical Society on some of its objects, stated that " the
fire-damp, when it escapes from the coal, has a con-
ling effect, and has not yet received that attention
erves. On the other hand, the heat generated by the
n of sulphides of iron is seldom noticed in the obser-
temperature." Sometime about 1879, Sir Lindsay
interesting experiments on the pressure of fire-damp
ithin coal-seams. It is well known that high tem-
e attained in working the Doe mine, at not incon-
pth. This seam is exceptionally liable to spon-
bustion.

eater depths are reached and higher temperatures
gineers will be called upon to experiment with a
ficial cooling. The use of water is open to two
water introduced into a deep mine would require
l out, and the saturation of the air greatly reduces the
he men for work.

the great Simplon tunnel has given me a personal
f the inconvenience of cooling the air by water. This
-tunnel piercing the Alps, one entrance being at
witzerland and the other at Iselle in Italy. The
of the tunnel will be over 12 miles, and the cost
£3,000,000. About 4,000 men have been employed
s side and about 6,000 on the Italian side. At
my visit, in May, 1904, the tunnel had been driven
es from the Swiss side. My observations gave the
perature in the air, 107° Fahr.; and where men
ed enlarging and putting in masonry, 97° Fahr.
wet bulbs both registered the same, the air was, there-
aturated. At seven or eight points, water was dis-
n pipes in the form of spray. Various arrange-
praying had been tried. The water-pipes were
insulating material (3 inches of charcoal) to keep
ol, and the water was under a pressure of 1,500
e square inch. The fresh-won rock was cooled by

water. Air is forced into one tunnel by two powerful fans, and returns by the main parallel tunnel. About 60,000 cubic feet of air per minute pass through the tunnels.

I was greatly pleased to see the excellent arrangements for the care of the workers: There is a convenient hospital, with a staff of nurses and attendants, well away from the works, with its outlook on the beautiful snowclad Alps. My train took in two attendants with all the necessary requirements to relieve 3 men injured by a fall of rock, where the main tunnel was being enlarged. A telephonic summons brought relief to the sufferers within half-an-hour of the accident. There are dressing-halls, equipped with hot and cold shower-baths, so that the workers can take off their working clothes to be dried, wash themselves, and put on dry clothes to go to their homes. Only about 10 per cent. of the men do not avail themselves of these arrangements. There are canteens, where well-cooked meals and pure, wholesome wine may be obtained at merely nominal prices—9d. a day for three meals: first meal: coffee, milk, sugar, bread, cheese; second meal: soup, meat, vegetables, salad, bread; third meal: thick soup and bread; and sleeping accommodation at 2d. per night for those requiring it.

The last Royal Coal Commission fixed 4,000 feet as the depth down to which our coal-resources were available. If the present Royal Commission adhere to that depth, as being the practicable depth at which coal may be worked, this conclusion will probably receive general approval, and it will enable a comparison to be made between the estimates of this Royal Commission and those of the last. Some people will wish to see a delineation of where deep coal may be found, with details as to the amount of coal between 4,000 feet and a deeper point.

It would, in a short address, be hardly possible to deal with the progress made in mining, or to attempt to suggest the subjects upon which papers might be contributed to this Society. Two suggestions, however, may be made: a small committee might be appointed to make observations in deep sinkings and in deep mines, in order that the best form of instrument be used, in the best manner, and to secure uniformity in the method of taking temperatures; another small committee might be appointed to

atch the borings, excavations and sinkings in the Upper Coal-
easures. If these committees made an annual report we should
ave a continuous record of progress in deep mining, and a col-
ction of information bearing upon the resources of the coal-field.

There has been marked progress in all the branches of
ining, in sinking, methods of working coal, ventilation, light-
ıg, the use of explosives and appliances for breaking down
al, haulage, banking arrangements, and sorting and cleaning
f coal. It is equally certain that further improvements will be
ıade. We have had recently valuable papers upon the applica-
ion of electricity and the cutting of coal by machinery. It may
e suggested that a paper on the use of compressed air would
e welcomed, and that there is room for considerable improve-
nent in the appliances for drilling holes in sinking pits, tunnels
r cross-measure drifts. Much progress has been made on the
ontinent in this direction.

Mining operations offer a wide field for the application of
ctricity. If the fact be fully recognized that its use has intro-
ed two new dangers, electrocution and the danger of fires
explosions of fire-damp, there may be, on the one hand,
ter care taken by users, and, on the other hand, continued
rts by electrical engineers to prevent those dangers from aris-

We have had two fatal cases from shock in Lancashire, one
contact with a defective switch-board, the other from
act with a defective cable; and we have had one very
strous fire established by a defective cable. From this
bited piece of repaired cable and the photographs, it will
bvious to you that electric cables should be repaired in a
er manner. It is extremely foolish to repair a broken
tric cable in the manner that a broken signal-cord would be
ired. It should further be clearly understood that the
ger of electricity is not only associated with high pressures;
der certain conditions, and they may be ordinary mining con-
ions, low pressures prove fatal.

In an address given four years ago it was shown that, by
aking note of the large increase in the number of persons
mployed in mining operations, the loss of life is very much
ss than when mining legislation was first applied. Shortly,
may be stated that mining is now 3½ times safer than at that

TABLE I.—SEPARATE FATAL ACCIDENTS IN AND ABOUT THE MINES OF GREAT BRITAIN AND IRELAND, UNDER THE COAL-MINES REGULATION ACTS.

PERIODS	Explosions of Fire-damp or Coal-dust.	Falls of Roof and Side.	Shafts.	Miscellaneous Belowground.	On Surface.	Totals.	Accidents per 1,000,000 Tons of Mineral raised.	Persons employed Aboveground and Belowground.	Tons of Mineral raised.
1.—1851-1855.									
Average per annum	92·8	350·4	204·8	88·2	44·6	780·8	13·41*	229,468	58,222,894*
Ratio per 1,000 Persons employed Aboveground and Belowground	0·40	1·53	0·89	0·39	0·19	3·40	...	...	...
2.—1860-1864.									
Average per annum	59·2	394·4	139·6	120·4	56·8	770·4	8·89*	291,172	86,627,076*
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·20	1·35	0·48	0·41	0·20	2·64	...	...	...
3.—1870-1874.									
Average per annum	51·6	430·0	134·0	185·0	83·0	883·6	6·93	438,568	127,492,781
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·12	0·98	0·30	0·42	0·19	2·01	...	...	...
4.—1880-1884.									
Average per annum	29·8	455·6	87·6	198·8	92·0	863·8	5·04	503,941	170,079,381
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·06	0·90	0·17	0·40	0·18	1·71	...	...	...
5.—1890-1894.									
Average per annum	18·8	427·8	83·8	210·4	119·2	860·0	4·48	674,450	191,789,652
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·03	0·63	0·12	0·31	0·18	1·27	...	...	...
6.—1895-1899.									
Average per annum	18·4	425·8	62·0	235·4	114·6	856·2	3·98	704,816	214,773,656
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·02	0·61	0·09	0·33	0·16	1·21	...	...	...
7.—1899-1903.									
Average per annum	20·6	469·6	68·8	259·2	129·0	947·2	3·99	796,530	237,182,973
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·026	0·589	0·086	0·325	0·162	1·189	...	...	...

Periods.	Explosions of Fire-damp and Coal-dust.	Falls of Roof and Side.	Shafts.	Miscellaneous Belowground.	On Surface.	Totals.	Deaths per 1,000,000 Tons of Mineral raised.	Persons employed Aboveground and Belowground.	Tons of Mineral raised.
1.—1851-1855.									
Average per annum	231·0	368·4	236·6	101·8	47·6	985·4	16·92*	229,468	58,222,894*
Ratio per 1,000 Persons employed Aboveground and Belowground ...	1·00	1·61	1·03	0·44	0·21	4·29	...	...	...
2.—1860-1864.									
Average per annum	185·8	407·8	163·0	175·2	60·2	992·0	11·45*	291,172	86,627,076*
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·64	1·40	0·56	0·60	0·20	3·40	...	...	...
3.—1870-1874.									
Average per annum	174·8	441·2	146·4	202·8	85·0	1,050·2	8·23	438,568	127,492,781
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·40	1·01	0·33	0·46	0·19	2·39	...	...	...
4.—1880-1884.									
Average per annum	212·8	466·2	100·4	207·0	92·4	1,078·8	6·30	503,941	171,079,381
Ratio per 1,000 Persons employed Aboveground and Belowground	0·42	0·93	0·20	0·41	0·18	2·14	...	..	...
5.—1890-1894.									
Average per annum	188·2	440·2	95·6	235·6	120·4	1,080·0	5·63	674,450	191,789,652
Ratio per 1,000 Persons employed Aboveground and Belowground .	0·28	0·65	0·14	0·35	0·18	1·60	...	...	...
6.—1895-1899.									
Average per annum	65·6	439·6	71·0	271·4	116·6	964·2	4·48	704,816	214,773,656
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·09	0·62	0·11	0·38	0·16	1·36	...	...	...
7.—1899-1903.									
Average per annum	60·2	486·2	78·2	270·2	130·2	1,025·0	4·32	796,530	237,182,973
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·075	0·608	0·098	0·339	0·163	1·286	...	...	...

* Coal alone.

TABLE I.—SEPARATE FATAL ACCIDENTS IN AND ABOUT THE MINES OF GREAT BRITAIN AND IRELAND, UNDER THE COAL-MINES REGULATION ACTS.

PERIODS	Explosions of Fire-damp or Coal-dust.	Falls of Roof and Side.	Shafts.	Miscellaneous Belowground.	On Surface.	Totals.	Accidents per 1,000,000 Tons of Mineral raised.	Persons employed Aboveground and Belowground.	Tons of Mineral raised.
1.—1851-1855.									
Average per annum	92·8	350·4	204·8	88·2	44·6	780·8	13·41*	229,468	58,222,894*
Ratio per 1,000 Persons employed Aboveground and Belowground	0·40	1·53	0·89	0·39	0·19	3·40	...	...	...
2.—1860-1864.									
Average per annum	59·2	394·4	139·6	120·4	56·8	770·4	8·89*	291,172	86,627,076*
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·20	1·35	0·48	0·41	0·20	2·64	...	...	...
3.—1870-1874.									
Average per annum	51·6	430·0	134·0	185·0	83·0	883·6	6·93	438,568	127,492,781
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·12	0·98	0·30	0·42	0·19	2·01	...	...	...
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Average per annum	29·8	455·6	87·6	198·8	92·0	863·8	5·04	503,941	170,079,381
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·06	0·90	0·17	0·40	0·18	1·71	...	...	...
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Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·03	0·63	0·12	0·31	0·18	1·27	...	...	...
6.—1895-1899.									
Average per annum	18·4	425·8	62·0	235·4	114·6	856·2	3·98	704,816	214,773,656
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·02	0·61	0·09	0·33	0·16	1·21	...	...	...
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Average per annum	20·6	469·6	68·8	259·2	129·0	947·2	3·99	796,530	237,182,973
Ratio per 1,000 Persons employed Aboveground and Belowground	0·026	0·589	0·086	0·325	0·162	1·189	...	...	...

* Coal alone

AND IRELAND, UNDER THE COAL-MINES REGULATION ACTS.

PERIODS.	Explosions of Fire-damp and Coal-dust.	Falls of Roof and Side.	Shafts.	Miscellaneous Belowground.	On Surface.	Totals.	Deaths per 1,000,000 Tons of Mineral raised.	Persons employed Aboveground and Belowground.	Tons of Mineral raised.
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Ratio per 1,000 Persons employed Aboveground and Belowground ...	1·00	1·61	1·03	0·44	0·21	4·29	...	...	...
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Ratio per 1,000 Persons employed Aboveground and Belowground	0·42	0·93	0·20	0·41	0·18	2·14	...	..	...
5.—1890-1894.									
Average per annum	188·2	440·2	95·6	235·6	120·4	1,080·0	5·63	674,450	191,789,652
Ratio per 1,000 Persons employed Aboveground and Belowground .	0·28	0·65	0·14	0·35	0·18	1·60	...	...	...
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Average per annum	65·6	439·6	71·0	271·4	116·6	964·2	4·48	704,816	214,773,656
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·09	0·62	0·11	0·38	0·16	1·36	...	...	...
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Average per annum	60·2	486·2	78·2	270·2	130·2	1,025·0	4·32	796,530	237,182,973
Ratio per 1,000 Persons employed Aboveground and Belowground ...	0·075	0·608	0·098	0·339	0·163	1·286	...	...	...

* Coal alone.

time. This improvement ought to be fully recognized. It should be encouraging to owners, managers and workers. It may be said that the work of the mining engineer is to produce coal at the lowest cost to life and limb, with reasonable capital expenditure; by facilitating the work of the hewer and the transport from the working-face, to enable the workers to earn good wages with profit to the employer.

Tables I. and II. show the number of persons employed, mineral raised, accidents and deaths for periods of 5 years from 1851. It is not my intention to weary you with details of these; they are for your consideration, to enable you to draw your own conclusions. It may briefly be remarked that, from 1851 to 1855, the average annual number of persons employed throughout the United Kingdom was 229,468; from 1860 to 1864, it was 291,172; and from 1899 to 1903, the average number was 796,530. The annual output of mineral from 1851 to 1855 was 58,222,894 tons; from 1860 to 1864 it was 86,627,076 tons; and from 1899 to 1903 it was 237,182,973 tons. The death-rate per thousand persons employed from 1851 to 1855 was 4·29; from 1860 to 1864, 3·40; and from 1899 to 1903 it was 1·286.

TABLE III.—NUMBER OF DEATHS FROM DIFFERENT CAUSES OF ACCIDENT IN THE LANCASHIRE AND CHESHIRE COAL-FIELD.

1899-1903.	Average per Annum.	Ratio per 1,000 Persons employed Aboveground and Belowground.
Explosions of Fire-damp and Coal-dust	5·8	0·064
Falls of Roof and Side	62·6	0·691
Shafts	7·8	0·086
Miscellaneous Belowground	28·8	0·317
Surface	11·8	0·130
Totals	116·8	1·289
Deaths per 1,000,000 Tons of Mineral raised ...	4·64	—
Persons employed Aboveground and Belowground	90,584	—
Tons of Mineral raised	25,181,133	—

The most striking feature in these tables is the large reduction in the loss of life from explosions: the death-rate from 1851 to 1855 was 1 per 1,000; and from 1899 to 1903 it was 0·075. The next feature is the reduction in shaft accidents: from 1851 to 1855 the death-rate was 1·03; and from 1899 to 1903 it was 0·098.

The Lancashire and Cheshire coal-field compares favourably

ith the United Kingdom in all other than the deaths from falls f roof and side. It can only be by continued, sustained effort iat the much to be desired reduction under this head will be rought about.

It is my concluding observation to express the desire that ou give your aid in endeavouring to reduce the great loss of fe from falls of roof and side.

Col. GEORGE H. HOLLINGWORTH said that the best thanks f the Society were due to Mr. Gerrard for his excellent and in-tructive address, one of the best to which he had listened; and .e had great pleasure in moving a hearty vote of thanks to him or it.

Mr. JOHN ASHWORTH seconded the proposal, which was arried by acclamation.

Prof. W. BOYD DAWKINS read the following paper on "A ection of the Glacial Deposits met with in the Construction of he New Docks at Salford":—

A SECTION OF THE GLACIAL DEPOSITS MET WITH IN THE CONSTRUCTION OF THE NEW DOCKS AT SALFORD.

By Prof. W. BOYD DAWKINS, D.Sc., F.R.S.

The new docks now under construction at Salford, for the Manchester Ship Canal Company, are excavated in the Glacial deposits filling the ancient valley of the Mersey. These are remarkable for their irregularity, and, in the section exposed at the time of the writer's visit in the autumn of 1903, showed the lenticular arrangement of the clays, sands and gravels of which they were formed. They varied within the distance of a few fe They contained the usual se worn pebbles and foreign an local stones, both angular an rounded, and more or le marked or smoothed by th action of ice. Among th foreign blocks, the andesit tuffs of the Lake country, a more particularly of Thirlme may be noted. Among those local derivation, a large blo of Coal-measure sandstone struck near the north-eastern corner of No. 9 dock, and in th line of the dock-wall. The writer is indebted to Mr. W. H. Hunter for the accompanying section, which he has kindly prepared for this paper (Fig. 1).

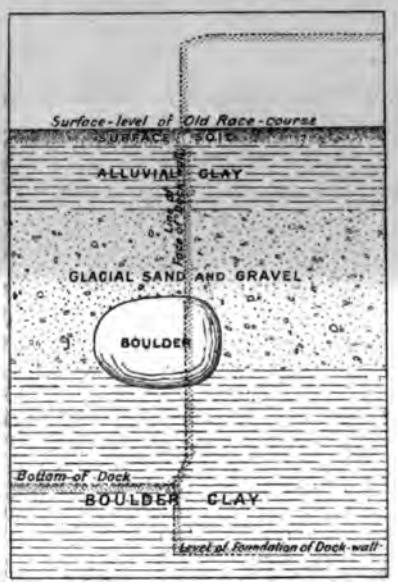

Fig. 1.—Section shewing the Position of the Large Boulder. Scale, 16 Feet to 1 Inch.

The block, so far as the writer's experience goes, is by far the largest as yet found in Lancashire in the Glacial drift. It

irregular rounded mass of Coal-measure sandstone, reddish- false-bedded, ripple-marked, and with the usual spangles ca. It weighed about 45 tons, or nearly twice as much • block of 25 tons of andesite-tuff found in Oxford Road, hester, and now in the quadrangle at Owens College. It ured 10 feet 6 inches in length, 7 feet 6 inches in depth and 6 inches in breadth, and was embedded in the lower part of lacial gravels and rested on the Boulder-clay below. Part as may be seen in the section, was left *in situ* behind the wall; the rest was broken up and carried away.

ıe section is as follows:—

No.	Description of Strata.	Thickness of Strata. Ft.	In.
1	Surface soil	1	8
2	Alluvial clay	5	3
3	Glacial sand and gravel	13	6
4	Boulder-clay	20	0

ıe boulder rested at the junction of Nos. 3 and 4 beds. It robably derived from some district in Lancashire, between 'd and the Lake-country.

r. Joseph Dickinson said that he had much pleasure in ıg a vote of thanks to Prof. Boyd Dawkins for the inter- description that he had given of the boulder; he men- the scratchings upon it and the work of the Glacial ice, e members might not be all agreed as to how those scratch- ame. They had been produced by friction in some way, (Mr. Dickinson) always considered that the "ice story was igh," although he bowed to the Professor's superior know-

. William Watts, in seconding the vote of thanks, said ≥ wished that they could have a more definite idea of what der was. He looked upon the local sandstone-grit blocks boulders, and preferred to keep the name of boulder anite rock. This was a water-borne stone. For 7½ he had been very extensively engaged in large excava- n the Little Don valley, on the other side of the Pennine and he had been frequently struck with the large number ıes which immediately underlay the clay-bed of the valley, every one of them being rounded or sub-angular and

ed with $\frac{1}{32}$ inch of silica. It would be interesting to kn
all these stones, both angular and sub-angular, beca
red with silica. They might have been floated there
or water in motion, but there did not appear to be a
ar evidence that ice-action had taken place in the Little D
ley—at all events, there were no traces of foreign boulde
ratic blocks or Boulder-clay. Possibly, at one time, a l
isted there, and the barrier which formed that lake wo
robably be in the gorge between Deepcar and Sheffield.

The resolution was adopted.

Prof. W. Boyd Dawkins, in acknowledging the vote of thanks, said that he had long observed in the valley of the Little Don, in the valley of the Derwent, and in some other valleys in that neighbourhood, on the east of the Pennine chain, that there was no drift with foreign stones such as occurred at similar levels on the western side. In the valleys where the Huddersfield reservoirs had been constructed, there was not enough clay for the puddle-trenches, and it was obtained from the Boulder-clay of Lancashire. This was due to the fact that the Pennine chain formed a barrier against the icebergs finding a way from the north-west to the south-east. It appeared that the ice could not pass over the higher ridges, but farther north, where the ridges were lower, the ice passed over in great force; and farther south, in the valley of the Trent and in the lower part of the valley of the Derwent, there were great sheets of Boulder-drift. At the place to which Mr. Watts referred there was n drift. He was not in a position to say what was going on in tho localities, in the Glacial period: there might have been lakes, b there was certainly now no evidence of the existence of icebergs those valleys, such as were found elsewhere and brought d great accumulations of Glacial sand and Boulder-clay and s from the Lake-country and from the Scotch Highlands. T accumulations were found from Macclesfield, extending r ward to the Lake-country and on to the margin of the S Highlands.

Prof. W. Boyd Dawkins read the following paper o Permian and Carboniferous Rocks in a Section in Higl Chorlton-on-Medlock, Manchester":—

THE PERMIAN AND CARBONIFEROUS ROCKS IN A SECTION IN HIGH STREET, CHORLTON-ON-MEDLOCK, MANCHESTER.

By Prof. W. BOYD DAWKINS, D.Sc., F.R.S.

The section accompanying this paper (Table I.) and, by the ourtesy of the Manchester Corporation, prepared by Mr. T. de ourcy Meade, the city-surveyor, relates to a boring at the ictoria Baths in High Street, completed in 1902. It is of reat interest, because it shows the necessity of a revision of ıe Geological Survey map of the area of Manchester, made by rof. Edward Hull as far back as 1862. It is also valuable, beıuse it proves the presence of large quantities of water in strata hich had hitherto been supposed to have little or none.

The Drift, 41 feet thick, in this section is part of the irregular antle covering the rocks of the area of Manchester, and ɔmands no special notice.

The red sandstone, 11 feet thick, is, in the writer's opinion, Permian age, and a continuation westward under the Drift those mapped as Permian at Ardwick and traversed in veral borings and well-sections in that district.

The red and blue marly shales, with limestones and sandones below, and penetrated in the boring to a depth of 708½ et, are Upper Coal-measures of the Ardwick series. The two in beds of limestone in the upper part of the section contain *pirorbis* and present the usual compact structure and grey-red loration of the *Spirorbis*-limestone. From the fact that the mestones here are two, instead of four in number as at Ardwick, may be inferred that the section begins near the bottom of the rdwick Limestones, and this is confirmed by the absence of the d of hæmatite and of the thin coals characteristic of the upper ds at Ardwick. It is obvious, therefore, that, in High Street, the pper coal-seams now being worked in the Manchester coalld are within an easy workable distance from the surface, stead of being, as shown on the Geological Survey map,

under a considerable thickness of Permians and of th[illegible]e
ic pebble-beds. The distance from the surface to the fir[illegible]st
able coal-seam (the Openshaw seam, 2 feet thick) is abo[illegible]ut
eet.

ABLE I.—SECTION OF STRATA IN A BORE-HOLE AT THE VICTORIA BATHS, HIGH STREET, CHORLTON-ON-MEDLOCK, MANCHESTER.

Description of Strata.	Thickness of Strata. Ft	In.	Depth from Surface. Ft.	In.
Soil	1	0	1	0
Red and blue boulder-clay	35	0	36	0
Gravel	5	0	41	0
Red sandstone rock	9	0	50	0
Sandstone	2	0	52	0
Marl	13	0	65	0
Blue marl	17	0	82	0
Dark-blue shale ...	8	0	90	0
Blue marl	4	0	94	0
Ardwick Limestone ...	11	6	105	6
Mottled marl ...	6	6	112	0
Red and blue marl ...	8	0	120	0
Calcareous shale ...	5	0	125	0
Blue marl	4	0	129	0
Mottled marl ...	2	0	131	0
Ardwick Limestone ...	2	0	133	0
Calcareous shale ...	5	0	138	0
Mottled marl ...	6	0	144	0
Blue shale	19	0	163	0
Blue sandy shale ...	16	0	179	0
Dark-blue shale ...	11	0	190	0
Blue sandy shale ...	15	0	205	0
Shale	6	0	211	0
Variegated shale ...	15	0	226	0
Grey rock	2	0	228	0
Sandy shale	1	0	229	0
Mottled marl ...	6	0	235	0
Sandy shale	2	0	237	0
Grey rock	13	0	250	0
Sandy shale	6	0	256	0
Grey rock ...	4	0	260	0
Blue shale	3	0	263	0
Dark shale	3	0	266	0
Grey shale	16	6	282	6
Rock	1	6	284	0
Sandy marl	7	0	291	0
Grey rock	5	0	296	0
Variegated shale ...	1	0	297	0
Rock	8	0	305	0
Variegated shale ...	6	0	311	0
Grey bind	6	0	317	0
Grey rock	11	0	328	0
Sandy shale	2	0	330	0
Dark shale	11	0	341	0
Shale	6	0	347	0
Grey rock	3	0	350	0
Sandy shale	12	0	362	0

No.	Description of Strata.	Thickness of Strata. Ft	In.	Depth from Surface. Ft.	In.
48	Grey rock	3	0	365	0
49	Sandy shale	12	0	377	0
50	Grey rock	10	0	387	0
51	Light shale	2	0	389	0
52	Variegated marl ...	10	0	399	0
53	Light shale	11	0	410	0
54	Grey shale	4	0	414	0
55	Dark shale	5	0	419	0
56	Sandy shale	10	0	429	0
57	Variegated shale	4	0	433	0
58	Grey shale	3	0	436	0
59	Sandy shale ...	9	0	445	0
60	Grey sandstone ...	3	0	448	0
61	Sandy shale	5	0	453	0
62	Dark shale	8	0	461	0
63	Brown shale	8	0	469	0
64	Variegated marl ...	17	0	486	0
65	Red marl	8	0	494	0
66	Variegated marl ...	18	0	512	0
67	Brown marl	23	0	535	0
68	Variegated marl ...	5	0	540	0
69	Blue shale	4	0	544	0
70	Variegated marl ...	6	0	550	0
71	Red marl	4	0	554	0
72	Variegated marl ...	10	0	564	0
73	Brown marl ...	4	0	568	0
74	Variegated marl ...	5	0	573	0
75	Marly and sandy shale-beds	2	0	575	0
76	Variegated marl ...	13	0	588	0
77	Red marl	14	0	602	0
78	Variegated marl ...	4	0	606	0
79	Red marl	26	0	632	0
80	Variegated marl ...	25	0	657	6
81	Red and blue bind ...	12	0	669	6
82	Variegated marl ...	4	0	673	6
83	Red marl	7	0	680	6
84	Variegated marl ...	9	6	690	0
85	Hard marl: variegated	4	0	694	0
86	Brown sandstone ...	11	6	705	6
87	Marl with sandstone-beds	4	0	709	6
88	Blue bind	4	0	713	6
89	Brown sandstone ...	4	0	717	6
90	Hard brown sandstone	9	6	727	0
91	Variegated marl ...	7	0	734	0
92	Sandy shale	20	0	754	0
93	Light blue sandy shale	6	6	760	6

The boring at High Street is 3,564 feet to the west of th
boundary shown on the Geological Survey map, as that betwe

the Pebble-beds and the Permian strata. It does not, however, follow that the Permians occupy the whole of the intervening area. Their general dip in this area is to the west, and if that had been maintained here, instead of being thin, they would have presented a thickness exceeding 100 feet. They are, therefore, probably on the upthrow side of a fault running in a northerly direction parallel to the other main faults in the district, but on this point further evidence is needed.

The boring was made for the supply of the Victoria Baths. It was directed to the water known to exist in the pebble-beds and in the Permian sandstone of the district. There were no pebble-beds, and the Permians were too thin to yield an adequate quantity of water. When the boring had attained a depth of 205 feet from the surface, in the Ardwick Limestone series, the writer advised the Corporation to abandon it, on the ground that as a rule there was little or no water in these rocks and that it was usually of bad quality. They, however, carried it down to a depth of 760½ feet, and have obtained a supply from the beds below the Ardwick Limestone of 8,000 gallons per hour, a supply, so far as the writer is aware, without precedent from a boring in these rocks. On these grounds alone, the writer thinks that the boring deserves to be put on record, as a contribution to our knowledge of the water available from borings in the Upper Coal-measures.

Mr. S. S. Platt, in moving a vote of thanks to Prof. W. Boyd Dawkins for his paper, said that one day he received an invitation from Mr. T. de Courcy Meade to visit the site of the boring in High Street, and on seeing the material that had been taken out he pronounced it as belonging to the Upper Coal-measures, and said he was afraid that the Corporation would find very little water below that depth. He was, however, glad to learn that Mr. Meade went on with his boring, and that a large supply of water had been found.

Mr. James Atherton seconded the proposal, which was adopted.

Mr. Joseph Dickinson said that, some years ago, he saw a letter in the newspapers from someone who described the finding of the Ardwick Limestone in the neighbourhood of

Withington, and the members knew that the cutting for the sewers at Levenshulme went through those beds, so that the up-throw of the Upper Coal-measures in that part of the district has been to some extent proved, since Dr. Hull filled in the map for the Geological Survey, without the information which is now known. There were intercepting faults, and that map took no cognizance whatever of them, and it would be well if Prof. Boyd Dawkins would gather together the facts that were known and lay them down for the revision of that map in the future. It was a pity, at this date, that information which was now superseded should still be published. There were many other errors; the carrying of the great fault from Manchester to Stockport was a thing that he could never look upon as correct, and the finding of Permian rocks at Radcliffe Bridge and Heaton Park were unnoticed on the map.

The PRESIDENT (Mr. John Gerrard) said that all would be agreed that these maps should be revised. It was of great importance, in connection with the extension of the coal-field, and especially in the neighbourhood of Manchester, that accurate geological information should be available. Prof. Boyd Dawkins and Mr. Dickinson had referred to the Heaton Park borings and to a very serious error in the Geological Survey map in association therewith. There were several wells in the neighbourhood of High Street, and the records of these wells might be of service to geologists, by affording information as to the position of faults and the continuation of the Coal-measures.

Prof. W. BOYD DAWKINS, replying to the discussion, said that he had many records of borings in Manchester, and Mr. Charles Chapman had many more. He hoped to mark their positions on the 6 inches Ordnance Map, for future use in the revision of the old map of the Geological Survey.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.

GENERAL MEETING,
HELD IN THE ROOMS OF THE SOCIETY, 5, JOHN DALTON STREET, MANCHESTER,
DECEMBER 13TH, 1904.

MR. JOHN GERRARD, PRESIDENT, IN THE CHAIR.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

Mr. STEPHEN EVERARD BASTOW, Hazlehurst, Whitefield, Manchester.
Mr. JOSEPH CARTER, Rainford Colliery, St. Helens, Lancashire.
Mr. JOSEPH CASS, Peasley Cross Colliery, St. Helens, Lancashire.
Mr. R. E. KNOWLES, Taylor Green Colliery, Springvale, Darwen.

ASSOCIATE MEMBER—

Mr. GEORGE BLACKWELL, The Albany, Liverpool.

Mr. JOHN J. WHITEHEAD'S "Notes on Coal in the Transvaal" were read as follow:—

NOTES ON COAL IN THE TRANSVAAL.

By J. J. WHITEHEAD.

Geology.—Carboniferous deposits of varied extent, quality and thickness are found in many parts of South Africa, but owing to the paucity of fossils, the precise geological age of these deposits has not been determined: they are, however, generally believed to be subaqueous and lacustrine. The only fossil brought to the writer's notice was *Glossopteris*, found near Brugspruit; *Calamites* and *Sigillaria* have also been found

TABLE I.—COAL-OUTPUT OF THE TRANSVAAL IN 1903.

District and Name of Company.	Coal Mined. Tons	Value £
Boksburg:		
Apex Mines, Limited	181,433	68,0[illegible]
Brakpan	249,617	89,[illegible]16
Cassel Coal Company, Limited: Springs ...	87,323	33,[illegible]26
Clydesdale (Transvaal) Collieries, Limited	218,430	94,[illegible]43
Great Eastern Collieries, Limited	159,861	60,[illegible]98
Springs	102,350	40,[illegible]48
Tyne Valley Colliery, Limited	92,712	37,[illegible]30
Victoria East Collieries, Limited	1,649	[illegible]77
Heidelberg:		
New Fortuna Company, Limited	4,962	1[illegible]489
Nigel Gold-mining Company, Limited ...	12,840	[illegible]677
South Rand Exploration Company, Limited	2,291	[illegible]145
Middelburg:		
Cardiff	1,902	707
Cassel Coal Company, Limited: Landau ...	41,623	1[illegible]481
Coronation Colliery Company, Limited ...	20,031	[illegible]953
Douglas Colliery, Limited	71,919	24,044
Natal Ocean Coal Company, Limited ...	656	282
Rogerston Collieries, Limited: Crown ...	63,488	23,771
Transvaal and Delagoa Bay Collieries, Limited	378,281	138,728
Transvaal Consolidated Coal-mines, Limited	33,372	13,468
United African Lands, Limited	363	182
Witbank Colliery, Limited	325,319	127,226
Zwartzkopjes	88	30
Vereeniging:		
Vereeniging Estates, Limited	207,674	99,772
Other Districts:		
Carolina	100	75
Totals	2,258,284	884,385

near Middelburg. Pending further development, research, and expert geological opinion, the question of the exact age of the beds, whether Triassic or Carboniferous, yet remains to be determined.

Production.—The Transvaal, the greatest coal-producer of the five South African colonies, may be divided into four districts, so far as production is concerned (isolated areas where sinking, trial or otherwise, is being carried on, being excluded). The output for 1903 of the various collieries in these districts is given in Table I.

The output for the past five years is given in Table II.

TABLE II.—COAL-OUTPUT OF THE TRANSVAAL FROM 1898.

	Coal Mined. Tons.	Value. £	Value per ton s.	d.
1898 ...	1,907,808	668,346	7	0·47
1899 ...	1,735,282	619,406	7	1·66
1900 ...	506,074	197,127	7	9·48
1901 ...	797,144	329,113	8	3·08
1902 ...	1,590,333	637,640	8	0·22
1903 ...	2,258,284	884,385	7	9·98

Boksburg District.—The Boksburg-Brakpan-Springs district, although having the largest output for 1903, produces, curiously enough, the most inferior coal of any. It extends from Boksburg eastward towards Springs, and is 16 miles long (Fig. 1, Plate XI.). Discovered in 1887, it was the only coal available when the Rand mines were opened up. Since then, however, coal of superior quality and cheaper to work has been discovered and opened up; especially that from Witbank, which, despite a high railway-rate, will, in the opinion of the writer, sooner or later drive out the East Rand coal from the market. Without the interest, direct or indirect, held by some of the gold-mining companies in the collieries of the East Rand, the output for 1903 would not have been so high; and, moreover, the number of collieries in the East Rand is decreasing, while those in the Middelburg district are increasing.

An average analysis of the coal in this district is as follows: Fixed carbon, 62 per cent.; volatile matter, 15·1 per cent.; moisture, 0·6 per cent.; sulphur, 0·3 per cent.; and ash, 22 per cent. One pound of the coal will evaporate 10·6 pounds of water.

The coal-seams in this district have a total thickness of about 80 feet. The coal is dull, of splinty appearance, weathers badly, and is very liable to spontaneous combustion. It is, moreover, costly to mine, and requires careful screening.

From a colliery manager's point of view, this district is perhaps the least interesting of any, although of special interest as regards the easterly extension of the gold reefs. The coal-measures of the East Rand lie upon the Witwatersrand formation.

In 1902, a bore-hole was put down by the Apex Mines, Limited, to a depth of 1,000 feet, and since continued to a total depth of 2,542 feet 9 inches, the Main Reef quartzitic shale being intersected at the depth of 1,576 feet. The Main Reef Leaders were intersected as follows:—At 1,468 feet 7 inches, 5 inches; 1,486 feet 6 inches, 3 inches; 1,487 feet 10 inches, 4 inches; and 1,492 feet 3 inches, 2 inches. The highest gold-value averaged 10 dwts. over the thickness of 4 inches. There was no Main Reef, but a series of white quartz-veins in a greenish quartzitic body, carrying no gold-value. The occurrence of the Main Reef contact at this depth was held to confirm the assumption of an upthrow fault; and the bore-hole was continued to the depth of 2,542 feet 9 inches, in order to complete the correlation with the underlying quartzites. The contact-schist was proved to be 614 feet thick, and the underlying quartzite contained diabase-intercalations of considerable thickness.

This information being incomplete, another bore-hole was put down on the north-eastern side of the property, to a depth of 2,873 feet. The Main Reef contact was intersected at 2,833 feet 6 inches. It is estimated that this, under ordinary conditions, should vary from 9 dwts. to 19 dwts., over a stoping width of 3 feet. These results are highly satisfactory, and form an asset of no mean order.

Further east, on the Welgedacht farm, three bore-holes have intersected the Main Reef at depths of 2,723 feet, 2,385 feet and 3,090 feet respectively. Farther eastward of this farm, boring is also being carried on, and, in all probability, the reef will be struck at an even greater depth.

Heidelberg District.—Coal-mining in the Heidelberg district is unimportant, although several isolated areas of coal are known

to exist, and some have been worked to a small extent. The Nigel Gold-mining Company, Limited, mine their own coal. The South Rand Exploration Company, Limited, have sunk two pits, 600 feet deep, to a seam 40 feet thick: the lower 11 feet only of which is being worked. This coal is of excellent quality, and equal to if not superior to Witbank coal. The plant, when erected, will be the most modern in the Transvaal. A colliery branch-line, about 12 miles long, is being made to connect this colliery with the main line.

Middelburg District.—The best coal worked in the Transvaal, comes from the vicinity of Witbank in the Middelburg district. The coal-measures, around Witbank and Brugspruit, have been proved by bore-holes to a depth of 500 feet, shewing six seams of coal. Owing, however, to denudation on an extensive scale, these six seams are by no means generally found throughout the district, and only in two instances, so far as the writer is aware, are they present (Appendix and Fig. 3, Plate XII.).

The measures, for the most part, consist of grits, sandstones, micaceous and carbonaceous shales and sandstones, interstratified with seams of coal of various thicknesses. The shales and sandstones, in almost every instance, form an excellent roof. The plan (Fig. 2, Plate XII.) shews the positions of the various collieries and farms where coal has been discovered: the writer however, particularly wishes to point out that coal has been discovered on many farms not shewn on the plan, but owing to these farms being situated a considerable distance from the railway, or the coal itself being of inferior quality, their indication on the plan was not considered necessary.

The most valuable seam, and the one most generally found throughout the district, is the No. 5 seam; and this is of varying quality (so far as shale and partings are concerned) and thickness.

In some cases, the seams have been opened up by adits only, and as the strata lie practically horizontal, little is known of the strata above and below the seams. Correlation, therefore, of the seams is not altogether easy, especially in view of the number of outcrops due to the undulating surface of the ground and to extensive denudation. For topographical surveys, however, in relation to the coal-measures, it is usual to work from the No. 5 seam as a datum-horizon, as struck by the bore-hole on

Blesboklaagte farm, north of Witbank station (Appendix No. 7 and Fig. 3, Plate XII.). The section in Witbank colliery is practically the same as that given by this bore-hole.

On the north side of the railway are situate three collieries, belonging to the Transvaal and Delagoa Bay Collieries, Limited, the Middelburg Steam Coal & Coke Company, Limited, and the Coronation Colliery Company, Limited, the two last-named being new. A section of the strata passed through in the Middelburg Steam Coal & Coke Company, Limited's No. 1 Pit is given in Appendix No. 1; and the same section may be taken as coincident with that passed through at the Coronation colliery; but the No. 5 seam at the latter colliery is inclined to be more shaly than at the Middelburg pit.

North of the railway-line, the country is somewhat flat, whereas to the south it is undulating. Sections are given in the appendix at Blauwkranz, Elandsfontein and Landau colliery (Klipfontein). In all probability, the No. 5 seam extends for some distance north and north-east of the Middelburg Steam Coal & Coke Company, Limited's holding.

Transvaal and Delagoa Bay Colliery.—This colliery is situated north-west of the railway-line on Driefontein farm, having an area of 4,450 acres, and working the No. 5 seam about 16 feet thick, from a pit 104 feet deep (Fig 3, Plate XII.). The coal is raised by a winding-engine with two cylinders, 13 inches in diameter by 2 feet stroke, geared 2½ to 1. The mine is worked by the pillar-and-stall system, with pillars 60 feet square, and stalls 22 feet wide. A branch-line, 3½ miles long, connects the colliery with the main line at Witbank station.

Middelburg Steam Coal & Coke Company, Limited.—Sinking operations for the present winding-shaft, No. 2 pit, commenced in April, 1903, and were concluded on May 23rd, at a depth of a little over 80 feet, when a seam 14½ feet thick was proved. Appendix No. 1 shews the strata passed through in the No. 1 pit (air-shaft, 7 feet by 5 feet) where the coal was 12½ feet thick. Here the measures are decidedly uniform, of a hard nature, affording splendid roof-protection to the seam, unlike many seams in the Transvaal, which lie near the surface with roofs of a broken nature, and are therefore much weathered and inferior in quality. The coal of this seam gives

an analysis second to none in the Transvaal at the present time. The following analysis of the coal of the No. 5 seam was made by Mr. E. Riley, London:—I.: Carbon, 75·53 per cent.; hydrogen, 5·50 per cent.; oxygen, 8·92 per cent.; nitrogen, 1·96 per cent.; sulphur, 1·07 per cent.; and ash, 7·02 per cent. II.: Volatile matter, 31·25 per cent.; and coke, 68·75 per cent. The specific gravity is 1·34. One pound of coal contains 7,810 calories, and will evaporate 14·54 pounds of water.

The area of the property is about 1,500 acres. The colliery is situate 1½ miles from Witbank station, with which it is connected by a siding. The output will shortly amount to 1,500 tons a day, dealt with by screening-plant of modern and approved type. A Worthington duplex-pump (with a steam-cylinder, 5 inches in diameter, and a ram 4 inches in diameter by 6 inches stroke) running 18 hours per day, pumps all the water (1,000 gallons an hour) made in the mine.

Coronation Colliery.—The area held by this company exceeds 1,000 acres, adjoining the southern boundary of that held by the Middelburg Steam Coal & Coke Company, Limited. There is one shaft on the property sunk to the No. 5 seam, which, although slightly thicker than at the adjoining colliery, is not so clean: the shale and partings being thicker. This colliery has siding-connection with the railway.

Witbank Colliery.—The colliery covers an area of 8,920 acres, the whole of which, with the exception of 1,000 acres, is freehold. The No. 5 seam varies from 12 to 16 feet in thickness. It is worked by the pillar-and-stall system, the pillars being 20 feet square and the stalls 20 feet wide. The seam is practically horizontal, makes little water, no gas, and the roof and floor are both excellent. The output is 1,300 tons a day, raised by a direct-acting winding-engine, with a cylinder 16 inches in diameter by 3½ feet stroke. The coal is screened on two belts, 40 feet long for round coal, and two smaller belts for small coal.

Landau Colliery.—This colliery, owned by the Cassel Coal Company, Limited, of Springs, suffered much during the war, the underground workings, apart from extensive surface-damage, being flooded to within a few feet of the surface. Two

ams are being worked, namely:—No. 1 seam, a smithy and
s coal; and No. 5 seam, a house and steam coal. The colliery
connected by a siding with Brugspruit station.

Methods of Working.—As a general rule, the stalls are drive
20 feet wide, and pillars are formed from 20 to 30 feet squar
Little or no timber is required. The seams make little wate
and fire-damp is practically unknown. It is usual in the No.
seam to work the bottom 6 feet, leaving the upper portion
the seam as a roof. The mine is divided into districts, so ma
boys (Kaffirs) being told off to each district under a wh
overseer; the boys do all the mining, holing, drilling, hewi
filling and tramming to the nearest shunt; but the blasting
dynamite) is done by the white overseer. The main roads
levels are worked by endless-rope haulage; the capac ity
of the tubs is about 20 cubic feet. The boys are paid 2s. a
and their food (mealie-meal); they live in a compound on
mine, and are well housed, fed and cared for. There is a sm all
hospital on every mine for the sick and injured; and on so me,
for the white workmen, a plunge-bath and a library.

Vereeniging Estates.—The coal-areas of these estates amo unt
to 97,000 acres. There are two collieries working:—The Cen tral
mine, north of the Vaal river in the Transvaal, and the Corne lia
mine, south of the Vaal river in the Orange River Colo ny.
Seams, 10 to 20 feet thick, are being worked at the Corne lia
mine, and 10 to 16 feet thick at the Central mine. The form er
mine is well equipped, having a wrought-iron headgear. Dou bt-
less the line, in relief of the present main line, from Vereenig ing
to Johannesburg, will prove of especial benefit to these collier ies,
as providing a shorter and easier route, in point of gradie nt,
to the West Rand gold-mines (Fig. 1, Plate XI.).

Other Districts.—An excellent seam of coal, probably the
No. 5 seam of the Witbank district, crops out on Kromdraai
farm, north of Wakefield station on the Pretoria-Middelburg
railway. The thickness at the face of an adit, 120 feet long, is
19 feet: the top coal, 8 feet thick, resembling, in the writer's
opinion, the bone coal of Lancashire, has been found to be an
excellent smithy coal, and the lower coal, 11 feet thick, is a

am and house coal. About ¾ mile east of the adit, two tangular prospecting shafts, 240 feet apart, have been sunk this seam, 45 and 63 feet deep respectively. Analyses of the l have been made as follows:—I.: Shaft, fixed carbon, 56·26 · cent.; volatile matter, 34·67 per cent.; ash, 8·74 per nt.; sulphur, 0·01 per cent.; and moisture, 0·32 per cent. : Adit, fixed carbon, 61·25 per cent.; volatile matter, 27·83 · cent.; ash, 9·75 per cent.; sulphur, 0·02 per cent.; and isture, 1·15 per cent. The yield of coke of the coal from the ıft was 64 per cent.; and from the adit 71·02 per cent. The ıporative efficiency averaged 12·1 pounds and 12·6 pounds of ter respectively. The area of available coal is about 2,000 es, but the distance from the railway (5 miles) appears to have vented this seam from being worked—and since the approxi- te cost of a colliery-siding in this colony is £4,000 a mile, it en forms an important item in the capital-account, apart from delay involved in its construction.

Douglas colliery, lying farther southwestward, on Goedver- uw farm, is working an excellent seam of coal 12 feet thick by adit; and possibly this seam is the same seam as that proved the Kromdraai farm.

Coal also exists north of the railway-line at Bronkhorstspruit, t of quality too inferior to merit more than passing mention.

About 19 miles southwest of Johannesburg, on the Vereenig- g to Johannesburg new railway, are three farms of interest ɔm a geological point of view. In this case, the coal, ally known as "drift coal," lies in the dolomite hollows, or large basins of dolomite, formed partly by the upheaval of e older rocks and partly by atmospheric and aqueous influ- ces; and into these basins or hollows the vegetable matter, w forming the seams, is supposed at some period to have been ıshed or drifted.

Much discussion has taken place as to the mode of forma- ɔn and the derivation of this carbonaceous matter. Mr. J. Logan, the late manager of the Cyferfontein colliery, referr- g to the basin extending from Cyferfontein into Zuurbekom rm, stated that within a certain area, the carbonaceous matter me from a southwesterly direction; a conclusion based on the facts that (*a*) the specific gravity of the vegetable

matter, being less than that of the later drift, such as mud, sand, etc., the carbonaceous matter would be carried to the farther ends of the basins; and (*b*) the best coal is found at the north-eastern end, and the inferior coal at the south-western end, of the basin.

Having had an opportunity of discussing this theory with Mr. Logan and of going over the ground, the writer is inclined to agree with him, so far as the dull coal is concerned; but not in regard to the bright coal, which is found interlaminated with the dull coal. In the Transvaal, the dull coal contains less volatile matter than the bright, and is generally found overlying the latter. Moreover, the writer is inclined to the theory that the bright coal was deposited *in situ*; that the dull coal was washed or drifted in at a later period, and that, while in course of transit, it was deprived of a certain amount of its volatile matter. In the No. 5 seam, at Witbank collieries, the bright coal contains in places thin streaks of dull coal; and the writer suggests that these streaks were caused by heavy tropical rains or floods. Divers opinions exist in the Transvaal as to the origin of the dull and the bright coal, much time has been spent in discussion, and new theories, from home, would prove welcome and refreshing.

The average of three analyses of the coal proved on the Cyferfontein farm is as follows:—Fixed carbon, 49·16 per cent.: volatile matter, 43·01 per cent.: and ash, 7·83 per cent.

On Zuurbekom farm, another similar coal-basin exists unproven, about 1,100 acres in extent; and yet another of abou 1,700 acres, also unproven, on the Klipriviersoog farm (Fig. 1 Plate XI.).

The shaft on the Cyferfontein farm was sunk to a depth 530 feet, when the dolomite was struck: 200 feet of carbo aceous matter was passed through, 70 feet of which was col sidered good marketable fuel. This colliery commenced windi coal shortly before the war, and it has not been restarted sin the conclusion of peace.

Several isolated areas of coal exist to the south and west of Heidelberg, and in certain cases they have been worked to a small extent.

At Onverwacht, northwest of Bethel, two seams of coal,

15 and 7 feet thick respectively, have been proved under an area of about 2,300 acres. These measures are supposed to rest upon the Witwatersrand formation. So far, this is mere conjecture, for in no instance on this farm can the underlying formation be seen.

Coal of good quality has been found at Bethel and Ermelo. An average analysis of coal from the Bethel district is as follows: Fixed carbon, 53·15 per cent.; volatile matter, 40·27 per cent.; sulphur, 0·08 per cent.; ash, 6·05 per cent.; and moisture, 0·45 per cent. The evaporative power is 12·4 pounds of water; and the coal yields 58·73 of coke. Until the Springs and Ermelo railway, now in course of construction, has been completed, mining in this neighbourhood, to any practical extent, may be considered impossible.

On the Witrand farm, south of Carolina, and 3 miles from the proposed railway from Carolina to Ermelo, seams 4 feet and 6 feet thick respectively have been proved by an adit and prospecting shaft. Nearer to Carolina, on the Droogvallei farm, another seam, varying in thickness from 2 feet 2 inches to 3 feet 2 inches, has been proved by three adits. An analysis yielded the following results:—Fixed carbon, 58 per cent.; volatile matter, 29 per cent.; sulphur 1·5 per cent.; and ash, 9·6 per cent. The evaporative power is 12 pounds of water.

As the cuttings, embankments and culverts are all constructed from Machadodorp to Carolina, the final completion of this section of the railway from Machadodorp to Ermelo may be expected in the near future.

On the Paardeplaats farm, adjoining the railway-line at Belfast, the Belfast colliery, owned by the Transvaal Consolidated Coal-mines, Limited, is working a seam of coal from 15 to 20 feet thick, under about 400 acres. The coal is shaly and high in ash. Operations in a small way have also been started by this company on the Honingkranz farm, near Baloral. Coal also exists on Blyvooruitzigt, south of Belfast, and on the Elandskloof, Haartebeestefontein, Lakenvlei and Swartzkopjes farms, north of Belfast.

On the Swartzkopjes farm, a seam 18 feet thick has been worked to a small extent, the coal being carted to Belfast by ox-waggon. This seam in the north-eastern corner of the farm, crops under a slight depression, under only 4 feet of soil and clay,

attention. English coke is selling in Johannesburg at £8 a ton, and Transvaal coke at £3: the latter being far below the market-value of the former, owing to its persistent tendency to crumble when exposed to the heat of the blast-furnace. Recently, however, a few tons manufactured from the No. 5 seam, at Witbank, have given better results.

APPENDIX.

No. 1.—No. 1 Shaft of the Middelburg Steam Coal and Coke Company, Limited.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	1	0	1	0
2	Gravel	6	0	7	0
3	Red clay	3	0	10	0
4	Sandstone and grit, soft	9	0	19	0
5	Sandstone and grit, very hard	22	0	41	0
6	Micaceous shale and sandstone	7	0	48	0
7	Carbonaceous shale ...	11	0	59	0
8	Micaceous shale and sandstone	8	6	67	6
9	Shale	1	6	69	0
	No. 5 Coal-seam—				
10	**COAL***	12	6	81	6
11	Coarse grit	0	6	82	0

* A coal-seam, 5 feet thick, has been proved below this seam.

No. 2.—No. 3 Bore-hole, at Blauwkranz Farm, near Brugspruit, for the Anglo-French (Transvaal) Navigation Coal Estates, Limited, 1897.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Sandy soil	20	0	20	0
2	Blue limestone (?) ...	35	0	55	0
3	Hard red sandstone ...	3	0	58	0
4	Blue limestone (?) ...	1	0	59	0
5	White sandstone ...	18	0	77	0
6	Hard grey sandstone	23	0	100	0
7	Sandstone and shale...	38	0	138	0
8	Hard shale	4	0	142	0
9	Shale	2	0	144	0
10	Grey sandstone ...	16	0	160	0
11	Sandstone and shale...	12	0	172	0
12	Hard fine sandstone...	18	0	190	0
13	Dark sandstone ...	12	0	202	0
14	Sandstone and shale...	3	0	205	0
	No. 1 Coal-seam—				
	Ft. In.				
15	**COAL** ... 1 3				
16	Shale ... 3 9				
17	**COAL** ... 5 6				
	——	10	6	215	6
18	Sandy shale	3	6	219	0
19	Shale	21	0	240	0
20	Coarse grey sandstone	7	0	247	0
21	Shale	0	6	247	6
22	Grey sandstone ...	3	6	251	0
	No. 2 Coal-seam—				
23	**COAL**	2	6	253	6
24	Hard grey sandstone	3	6	257	0
	No. 3 Coal-seam—				
25	**COAL** (no details given)	24	0	281	0
26	Dark sandstone ...	19	0	300	0
	No. 4 Coal-seam—				
27	**COAL**	0	6	300	6
28	Dark sandstone ...	3	0	303	6
29	Sandy shale	14	0	317	6
30	Shale	8	0	325	6
31	Sandy shale	15	0	340	6
	No. 5 Coal-seam—				
	Ft. In.				
32	**COAL** ... 10 0				
33	Shale ... 0 6				
34	Sandstone... 1 6				
35	**COAL** ... 8 0				
	——	20	0	360	6
36	Sandstone	13	6	374	0
	No. 6 Coal-seam—				
37	**COAL**	4	3	378	3
38	Conglomerate sandstone	34	3	412	6
39	Dark fine sandstone...	25	0	437	6
40	Hard shaly slate ...	25	0	462	6
41	Broken slate	5	0	467	6
42	Hard slate	6	0	473	6
43	Gritty slate	2	0	475	6
44	Slate	12	0	487	6

No. 3.—No. 1 Pit, at Elandsfontein Farm, near Brugspruit, for the Anglo-French (Transvaal) Navigation Coal Estates, Limited.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Red soil	5	0	5	0
2	Hard soil	4	0	9	0
3	Yellow clay	23	0	32	0
4	Coarse sandstone ...	2	0	34	0
5	Yellow clay	0	9	34	9
6	Red sandstone ...	0	6	35	3
7	Yellow clay	2	9	38	0
8	Yellow sandy clay ...	4	0	42	0
9	Black clay	2	6	44	6
10	Clay and shale ...	5	6	50	0
11	Dark shale	6	0	56	0
12	Red sandstone ...	1	0	57	0
13	Hard dark-grey shale	10	0	67	0
14	Dark sandstone ...	2	6	69	6
15	Grey sandstone ...	2	6	72	0
	No. 5 Coal-seam—				
		Ft.	In.		
16	**COAL** ...	1	6		
17	Dark shale ...	0	6		
18	**COAL**, shaly	1	5		
19	**COAL**, shaly	1	7		
20	**COAL**, shaly	1	0		
21	**COAL**, shaly	3	2		
22	**COAL** ...	12	10		
				22	0
				94	0

No. 4. No. 2 Bore-hole, at Klipfontein Farm, near Brugspruit, for the Landau Transvaal Colliery Company.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	4	6	4	6
2	Gravel...	1	0	5	6
3	Soft white sandstone	8	6	14	0
4	Soft brown sandstone	27	0	41	0
5	Sandstone and shale...	45	9	86	9
	No. 1 Coal-seam—				
6	**COAL**	7	0	93	9
7	Shale	5	11	99	8
8	Sandstone	0	4	100	0
9	Shale	0	6	100	6
10	Sandstone	4	0	104	6
11	Grey shale	4	0	108	6
12	Black shale	16	6	125	0
	No. 2 Coal-seam—				
13	**COAL**	0	6	125	6
14	Conglomerate grits ...	1	6	127	0
15	Sandstone	1	0	128	0
16	Shale	0	6	128	6
	No. 3 Coal-seam—				
		Ft.	In.		
17	**COAL** ...	0	6		
18	Shale ...	1	4		
19	**COAL** ...	0	8		
20	Shale ...	1	0		
21	**COAL** ...	1	2		
22	Shale ...	0	6		
23	**COAL** ...	1	7		
24	Shale ...	0	3		
25	**COAL** ...	6	0		
26	Shale ...	2	0		
27	**COAL** ...	7	6		
		22	6	151	0
28	Shale	2	6	153	6
29	Conglomerate ...	5	0	158	6
30	Gritty conglomerate	10	0	168	6
31	Grey shale	1	0	169	6
	No. 4 Coal-seam—				
32	**COAL**	1	0	170	6
33	Shale	1	0	171	6
34	Grits	7	0	178	6
35	Sandstone and grits...	5	0	183	6
36	Grey shale	2	0	185	6
37	Dark shale	22	6	208	0
38	Grit	0	3	208	3
	No. 5 Coal-seam—				
		Ft.	In.		
39	**COAL**, semi-bituminous	7	0		
40	**COAL**, bright	9	10		
		16	10	225	1
41	Sandstone and shale	2	2	227	3
42	Conglomerate ...	4	6	231	9
43	Gritty sandstone ...	0	10	232	7
44	Shale	0	2	232	9
45	**COAL**	3	10	236	7
46	Shale	0	4	236	11
47	Gritty sandstone ...	10	0	246	11
48	Conglomerate ...	1	0	247	11
	No. 6 Coal-seam—				
49	**COAL**	3	8	251	7
50	Gritty sandstone ...	0	4	251	11
51	Conglomerate ...	—		—	

No. 5.—No. 1 Prospecting Shaft on the Kromdraai Farm.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	10	0	10	0
2	Sandstone	34	0	44	0
3	**COAL**	19	0	63	0

The summit from the Swiss side was reached without serious difficulty from drainage, though infiltrations amounting to 744 gallons a minute had to be dealt with, exclusive of the water artificially introduced for refrigerating appliances, rock-borers and other services. This driving has gone 2,658 feet beyond the summit, and in that distance embarrassing springs of water have been encountered, with a flow of 1,608 gallons a minute. This inflow, together with the water artificially introduced, amounts to 3,672 gallons a minute. The trouble of dealing with this inflow of water was further increased in the last 600 feet by 13 springs of hot water yielding 595 gallons a minute, the temperature varying from 104° to 117° Fahr. The men worked with waterproofs under the hot cascades, and the floor was submerged knee-deep.

The heat radiated by the rock through which the water flows, as measured in bore-holes about 5 feet in depth, amounted to between 97° and 99½° Fahr. and had to be kept down by great jets of water playing on the walls of the tunnel; and the temperature of the air was reduced to between 81° and 91° Fahr. by sprays of water—care also being taken to keep the water for cooling purposes as cool as possible, by running it in pipes lagged with broken charcoal in a casing of thin sheet-metal, as well as running away the escape-water in wooden casings, preferably to iron, on account of the non-conductivity of wood.

Since then, two other hot springs, yielding 480 gallons a minute, have increased the temperature, and the space for piping near the face being inadequate, the driving from the Swiss side has been discontinued. In this discontinued portion a large body of accumulated water is left to be dealt with hereafter.

Meanwhile, operations are being continued from the Italian side, where gravitational drainage is less difficult. Yet, even here, a hot spring, of 960 gallons a minute at a temperature of 114° Fahr., has been encountered.

It is supposed, from the variations of temperature, that the springs may not all be connected, but from the nature of the rock this is uncertain. It is hoped that more hot water will not be met with, and that the tapping of the accumulated water on the dip of the Swiss side, when the headings meet, will be the only remaining difficulty to be encountered.

The meeting of headings from entrances about 12 miles

apart, and driven at different gradients, through a mountain-range, requires in itself fine engineering, irrespective of the other difficulties mentioned.

Mention has not been made as to the actual kind of rock met with in the Simplon tunnel. When the Mont Cenis tunnel was being driven through the Alps, the writer visited the face of the driving, about 3 miles in from the Savoy side. There was then a seam of coal between beds of Silurian-like rock. Other beds of similar coal had long been worked in the vicinity. A peculiarity that he noticed, in and out of the mines, was that the seams began in wedge-shape between enormous beds of rock, often swelling out, sometimes to 6 or more feet in thickness, and then they similarly tapered off and disappeared. Another peculiarity was that nowhere under the seams did he find any *Stigmaria ficoides*, such as occurs in the floor under coal-seams in British coal-fields.

A vote of thanks was heartily accorded to Mr. Dickinson for his paper.

HE INSTITUTION OF MINING ENGINEERS.

FTEENTH ANNUAL REPORT OF THE COUNCIL

The six societies constituting The Institution of Mini g
gineers are the same as last year, namely, the Midla d
ounties Institution of Engineers; the Midland Institute of
Mining, Civil and Mechanical Engineers; the Midland Institute te
of Scotland; the North of England Institute of Mining Engineers; the Mining Institu d
Mechanical Engineers; the North Staffordshire Institute of Mining a f
Mining and Mechanical Engineers; and the South Staffordshi e
and East Worcestershire Institute of Mining Engineers.

The following table exhibits the progress of the membersh p
since the formation of the Institution in 1889:—

Year ending July 31st.	No. of Honorary Members.	No. of Members.	No. of Non-federated.	Totals.
1890	0	1,189	50	1,239
1891	0	1,187	9	1,196
1892	14	1,401	19	1,434
1893	14	1,519	19	1,552
1894	13	2,055	123	2,191
1895	13	2,197	109	2,319
1896	13	2,288	81	2,382
1897	13	2,434	60	2,507
1898	15	2,449	47	2,509
1899	15	2,430	41	2,486
1900	15	2,432	35	2,482
1901	15	2,509	30	2,554
1902	17	2,556	30	2,601
1903	17	2,645	26	2,688
1904	17	2,742	22	2,781

The Manchester Geological and Mining Society havi
applied to join The Institution of Mining Engineers from Aug
1st, 1904, their request was cordially agreed to. The federation
this society with the Institution of Mining Engineers will ad
considerable number to the membership, and the inclusion of th
papers read before that Society will materially increase the va
of the *Transactions*.

The Annual General Meeting of the Institution was held i
Nottingham on September 2nd, 3rd and 4th, 1903. The Lond
Meeting was held on June 2nd and 3rd, 1904. Both of thes
meetings secured the attendance of a large number of members
The thanks of the Institution have been sent to the owners o
collieries, works, etc., which were thrown open to the member
attending these meetings.

Clement Le Neve Foster was elected an Honorary Member Institution in February, 1904. The Council record with gret his sudden death; and a vote of sympathy and condo- as been sent to his widow and family.

zes have been awarded to the writers of the following , which are printed in the *Transactions* (vols. xxiv. and —

The Fernie Explosion." By Mr. William Blakemore.

Sinking by the Freezing Method at Washington, County Durham." By Mr. Mark Ford.

Miners' Anæmia, or Ankylostomiasis." By Dr. J. S. Haldane.

The Marl-slate and Yellow Sands of Northumberland and Durham." By Prof. G. A. Lebour.

The Occurrence of Gold in Great Britain and Ireland." By Mr. J. Malcolm Maclaren.

The Probability of Finding Workable Seams of Coal in the Carboniferous Limestone or Bernician Formation, beneath the Regular Coal-measures of Northumberland and Durham, with an Account of a recent Deep Boring made, in Chopwell Woods, below the Brockwell Seam." By Mr. J. B. Simpson.

dresses have been delivered during the year by Mr. James adman, President of The Institution of Mining Engineers; . W. B. M. Jackson, President of the Midland Counties ıtion of Engineers; by Mr. Robert T. Moore, President Mining Institute of Scotland; by Mr. A. M. Henshaw, ent of the North Staffordshire Institute of Mining and nical Engineers; and by Mr. Isaac Meachem, jun., ent of the South Staffordshire and East Worcestershire ıte of Mining Engineers.

e papers published in the *Transactions* during the past year ɔeen of a varied character, and the high standard of the *ɪctions* has been well maintained. The Council trust that ɔmbers will contribute papers in the future as liberally as past.

e papers on geology include the following:—

The Rock-slide at Frank, Alberta Territory, Canada." By Mr. W. M. Brewer.

The Occurrence, Mode of Working, and Treatment of the Ironstones found in the North Staffordshire Coal-field." By Mr. John Cadman.

'The Occurrence of Calcareous Coal in a Lanarkshire Coal-field." By Mr. Robert W. Dron.

'Petroleum, and its Use for Illumination, Lubricating and Fuel-purposes." By Dr. P. Dvorkovitz.

'The Coal-fields of the Faröe Islands." By Mr. G. A. Greener.

'Some Silver-bearing Veins of Mexico." By Mr. Edward Halse.

surveying and instruments have been treated of in the
papers:—
he Hammer-Fennel Tachymeter-theodolite." By Mr. Adolphus F. Ecroll.
Notes of Surveys and Levellings in Canada." By Mr. George L. Griffith.
The Transmission of Errors in Traverse-surveying." By Prof. G. R.
Thompson.

e miscellaneous papers comprize:—
"Miners' Phthisis." By Mr. James Barrowman.
"Weldless Steel Pit-props." By Mr. M. Walton Brown.
"Memoir of the late William Cochrane." By Mr. Cecil A. Cochrane.
"Petroleum, and its Use for Illumination, Lubricating and Fuel-purposes."
By Dr. P. Dvorkovitz.
"Report of the Delegate to the Conference of Delegates of Corresponding
Societies of the British Association for the Advancement of Science,
Southport, 1903." By Mr. John Gerrard.
"Ankylostomiasis: the Worm-disease in Mines." By Mr. Francis
William Gray.
"Underground Temperatures, especially in Coal-mines." By Prof. Hans
Hoefer.
"Notes on Early Mining in Staffordshire and Warwickshire." By Mr. J.
H. Jackson.
"Fires in Mines, with Particular Reference to Seams in the North Staffor-
shire Coal-field." By Mr. G. E. Lawton.
"The Analytical Valuation of Gas-coals." By Dr. G. P. Lishman.
"Record of the Failure of a Locked-coil Winding-rope." By Mr. William
Lockett.
"Slack-washing: Preliminary Treatment for the Extraction of Fine Dust."
By Mr. McD. Mackey.

The preceding list, comprizing 64 papers, demonstrates the
varied nature of the subjects dealt with in the *Transactions*
(vols. xxvi. and xxvii.). During the past year "Notes of Papers
(161) on the Working of Mines, Metallurgy, etc., from the
Transactions of Colonial and Foreign Societies and Colonies
and Foreign Publications" have been continued, and should
prove of value to the members.

Members can purchase, at privileged prices, copies of the
Transactions of the following Corresponding Societies:—

Australasian Institute of Mining Engineers.
Canadian Mining Institute.
Mining Society of Nova Scotia.

Prof. Henry Louis represented the Institution at the meeting
of the Corresponding Societies of the British Association for the
Advancement of Science, held at Southport in September, 1903.

THE LOCAL INSTITUTES ... ACCOUNT WITH THE INSTITUTION OF MINING ENGINEERS,

FOR THE YEAR ENDING JULY 31ST, 1904.

Dr.	No. of Members. Federated.	No. of Members. Non-Federated.	Balance due at the beginning of the year.	Amounts falling due during the Year. Calls made during the year.	Excerpts.	Transactions, etc.	Totals.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Midland Counties Institution of Engineers	352	...	20 19 0	33₂ 8 0	0 0 0	29 0 0	384 7 0
Midland Institute of Mining, Civil and Mechanical Engineers	311	...	3 9 9	295 9 0	6 16 0	9 0 0	314 14 9
Mining Institute of Scotland	465	22	7 11 8	452 15 0	12 19 2	4 0 0	477 5 10
North of England Institute of Mining and Mechanical Engineers	1,320	...	71 7 3	1,254 0 0	51 9 0	67 18 9	1,444 15 0
North Staffordshire Institute of Mining and Mechanical Engineers	195	...	32 8 7	185 5 0	2 11 6	10 0 0	230 5 1
South Staffordshire and East Worcestershire Institute of Mining Engineers...	99	...	24 11 8	94 1 0	0 14 6	11 0 0	130 7 2
Totals	2,742	22	160 7 11	2,615 18 0	74 10 2	130 18 9	2,981 14 10

Cr.	Amounts Paid during the Year. Balance from previous year.	Calls.	Excerpts.	Transactions, etc.	Totals.	Balance due at July 31st, 1904.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Midland Counties Institution of Engineers	20 19 0	327 15 0	0 0 0	28 0 0	376 14 0	7 13 0
Midland Institute of Mining, Civil and Mechanical Engineers	3 9 9	288 16 0	6 16 0	4 0 0	303 1 9	11 13 0
Mining Institute of Scotland	7 11 8	451 16 0	12 19 2	4 0 0	476 6 10	0 19 0
North of England Institute of Mining and Mechanical Engineers	71 7 3	1,196 1 0	51 9 0	66 18 9	1,385 16 0	58 19 0
North Staffordshire Institute of Mining and Mechanical Engineers	32 8 7	179 11 0	2 11 6	9 0 0	223 11 1	6 14 0
South Staffordshire and East Worcestershire Institute of Mining Engineers	24 11 8	76 19 0	0 0 0	0 0 0	101 10 8	28 16 6
Totals	160 7 11	2,520 18 0	73 15 8	111 18 9	2,867 0 4	114 14 6

ACCOUNTS.

THE TREASURERS IN ACCOUNT WITH
FOR THE YEAR

	£ s. d.	£ s. d.
31, 1903.		
Balance at Bank, Current Account	385 17 11	
„ „ Deposit Account	1,283 16 11	
„ in Cashier's hands...	104 1 0	
		1,773 15 10
y 31, 1904.		
Subscriptions for the Year ending July 31, 1902—		
Federated—		
North Staffordshire Institute of Mining and Mechanical Engineers		6 1 0
To Subscriptions for the Year ending July 31, 1903—		
Federated—		
Midland Counties Institution of Engineers	19 19 0	
Midland Institute of Mining, Civil and Mechanical Engineers	1 18 0	
Mining Institute of Scotland	4 5 0	
North of England Institute of Mining and Mechanical Engineers	59 17 0	
North Staffordshire Institute of Mining and Mechanical Engineers	17 2 0	
South Staffordshire and East Worcestershire Institute of Mining Engineers	14 5 0	
		117 0
To Subscriptions for the Year ending July 31, 1904—		
Federated—		
Midland Counties Institution of Engineers	327 15 0	
Midland Institute of Mining, Civil and Mechanical Engineers	288 16 0	
Mining Institute of Scotland	440 16 0	
North of England Institute of Mining and Mechanical Engineers	1,196 1 0	
North Staffordshire Institute of Mining and Mechanical Engineers	179 11 0	
South Staffordshire and East Worcestershire Institute of Mining Engineers	76 19 0	
		2,509 18 0
Non-Federated—		
Mining Institute of Scotland	11	0 0
Carried forward	£4,418	12 10

INSTITUTION OF MINING ENGINEERS. Cr.
NG JULY 31, 1904.

31, 1904.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
rinting—												
ransactions, vol. xx., printing ...	11	10	0									
				11	10	0						
,, ,, xxi., printing ...	0	1	3									
,, ,, ,, plates ...	5	0	0									
				5	1	3						
,, ,, xxii., plates ...	10	6	0									
				10	6	0						
,, ,, xxiii., printing ..	59	5	8									
,, ,, ,, plates ...	47	8	9									
				106	14	5						
,, ,, xxiv., printing ...	272	7	6									
,, ,, ,, plates ...	75	15	0									
				348	2	6						
,, ,, xxv., printing ...	357	0	6									
,, ,, ,, plates ...	130	3	7									
				487	4	1						
,, ,, xxvi., printing ...	420	10	8									
,, ,, plates ...	128	1	9									
				548	12	5						
,, ,, xxvii., printing...	134	3	8									
,, ,, ,, plates ...	40	6	7									
				174	10	3						
							1,692	0	11			
xcerpts, vol. xii.				1	12	6						
,, ,, xiv.				2	10	0						
,, ,, xxi.				5	3	9						
,, ,, xxii.				0	11	0						
,, ,, xxiii.				16	2	3						
,, ,, xxiv.				17	10	4						
,, ,, xxv.				66	6	10						
,, ,, xxvi.				41	6	9						
,, ,, xxvii.				16	18	8						
							168	2	1			
oofs of Papers for General Meetings				.....			18	5	9			
rculars				.....			36	7	1			
										1,914	15	10
ldressing *Transactions*, etc.				...		...	40	13	3			
amps—Circulars				18	5	1						
,, Correspondence				24	2	6½						
,, *Transactions*				389	6	11½						
							431	14	7			
ationery, etc.				...		...	119	8	5			
surance of *Transactions*				...		...	3	0	0			
Carried forward							£594	16	3	£1,914	15	10

Dr. THE TREASURERS IN ACCOUNT WI

	£ s. d.	£ s. d.	£ s.
Brought forward			4,418 1 2
To Local Publications and Authors' Copies—	1902-1903.	1903-1904.	
The Institution of Mining Engineers	0 0 0	41 14 9	
Midland Counties Institution of Engineers ...	0 0 0	0 0 0	
Midland Institute of Mining, Civil and Mechanical Engineers	0 11 9	6 16 0	
Mining Institute of Scotland	0 0 0	12 19 2	
North of England Institute of Mining and Mechanical Engineers	8 10 3	51 9 0	
North Staffordshire Institute of Mining and Mechanical Engineers	5 6 11	2 11 6	
South Staffordshire and East Worcestershire Institute of Mining Engineers	0 0 0	0 0 0	
	14 8 11	115 10 5	129
To Sales of Transactions, etc.—	1902-1903.	1903-1904.	
The Institution of Mining Engineers	0 0 0	192 1 8	
Midland Counties Institution of Engineers ...	1 0 0	28 0 0	
Midland Institute of Mining, Civil and Mechanical Engineers	1 0 0	4 0 0	
Mining Institute of Scotland	3 6 8	4 0 0	
North of England Institute of Mining and Mechanical Engineers	3 0 0	66 18 9	
North Staffordshire Institute of Mining and Mechanical Engineers	3 6 8	9 0 0	
South Staffordshire and East Worcestershire Institute of Mining Engineers	10 6 8	0 0 0	
	22 0 0	304 0 5	326
To Advertizements		437 9 7	
To Address Labels		3 13 0	
To Interest on Deposit Account		18 17 7	
To Interest on Investment		19 1 8	479
			£5,353 14 5

UTION OF MINING ENGINEERS.—*Continued.* Cr.

	£ s. d.	£ s. d.	£ s. d.
ght forward	... ...	594 16 3	1,914 15 10
–Library	0 13 11		
Sundries...	0 3 6		
Transactions	53 17 3		
		54 14 8	
g General Meetings	... ...	33 17 9	
of General Meetings	... ...	37 8 10	
l Expenses	... ...	28 10 0	
Wages, Auditing, etc.	... ...	762 14 6	
Transactions	... ...	23 16 0	
g Expenses	... ...	17 18 9	
			1,553 16 9
ons of Papers	... ...	3 5 0	
of Foreign Papers, vol. xxiv. ...	71 7 8		
„ „ xxv. ...	47 3 9		
„ „ xxvi....	6 6 0		
		124 17 5	
r Readings, etc.	... ...	7 3 6	
s	... ...	13 13 6	
... ...	... ...	8 19 6	
—Seymour Technical Library	... ...	15 15 0	
			173 13 11
			3,642 6 6
nt of Excerpts :—			
Institute of Scotland	... ...	10 2 3	
E gland Institute of Mining and Mechani-			
gineers	... ...	6 5 6	
taffordshire and East Worcestershire Insti-			
f Mining Engineers	... ...	0 10 0	
			16 17 9
nt with River Tyne Commission	... ...	1,000 0 0	
at Bank, Current Account ...	... ...	228 10 8	
„ Deposit Account, including Interest		413 17 11	
n Cashier's hands	... ...	52 1 7	
			1,694 10 2

ave examined the above account of receipts and payments, books and vouchers relating thereto, and certify that in on it is correct.

JOHN G. BENSON & SONS,
Chartered Accountants.

rtle-upon-Tyne.
August 8th, 1904.

£5,353 14 5

THE INSTITUTION OF
BALANCE SHEET,

Liabilities.

July 31st, 1904.	£ s. d.	£ s. d.
Sundry Creditors—		
Advertizements paid in Advance	31 18 11	
Printing, etc.	1,050 0 0	
Postage of Transactions	210 0 0	
Abstracts of Foreign Papers in Volumes xxvi. and xxvii.	140 0 0	
Barometer Readings	8 0 0	
Prizes for Papers in Volumes xxiv., xxv., xxvi. and xxvii.	80 0 0	
Indexing Volumes xxv., xxvi. and xxvii.	60 0 0	
		1,579 [illegible] 11
Balance of Assets over Liabilities, exclusive of the Value of the Stock of *Transactions*, etc.		440 [illegible] 6
		£2,020 9 5

We have examined the above Balance Sheet, with the books and vouchers relating thereto, and certify that in our opinion it exhibits a correct view of the affairs of the Institution.

JOHN G. BENSON & SONS,
Chartered Accountants.

Newcastle-upon-Tyne,
February 10th, 1905.

GINEERS.
04.

Assets.

04.	£ s. d.	£ s. d.
ank, Current Account	228 10 8	
Deposit Account, including Interest	413 17 11	
ashier's hands	52 1 7	
with River Tyne Commission	1,000 0 0	
,, ,, Interest to date	11 2 9	
		1,705 12 11
s for the Year ending July 31, 1904, Unpaid—		
rated—		
Counties Institution of Engineers	6 13 0	
Institute of Mining, Civil and Mechanical ers	6 13 0	
nstitute of Scotland	0 19 0	
England Institute of Mining and Mechanical ers	57 19 0	
affordshire Institute of Mining and Mechanical ers	5 14 0	
affordshire and East Worcestershire Institute ing Engineers	17 2 0	
		95 0 0
ations and Authors' Copies, Unpaid—		
affordshire and East Worcestershire Institute ing Engineers	0 14 6	
		0 14 6
Sold, Unpaid—		
on of Mining Engineers	17 1 3	
Counties Institution of Engineers	1 0 0	
Institute of Mining, Civil and Mechanical ers	5 0 0	
England Institute of Mining and Mechanical ers	1 0 0	
affordshire Institute of Mining and Mechanical ers	1 0 0	
affordshire and East Worcestershire Institute ing Engineers	11 0 0	
		36 1 3
nts, Unpaid		183 0 9
		£2,020 9 5

BOOKS, ETC., ADDED TO THE LIBRARY.

African Review, London. Vol. xxxvi., Nos. 564-566; vol. xxxvii., Nos. 567-579; vol. xxxviii., Nos. 580-592; vol. xxxix., Nos. 593-606; and vol. xl., Nos. 607-610.

Annales des Mines de Belgique, Bruxelles. Vol. viii., No. 4; and vol. ix., Nos. 1 and 2.

Australasian Institute of Mining Engineers, Melbourne. Transactions, vol. ix., No. 2.

British Society of Mining Students, Medomsley. Journal, vol. xxv., Index and vol. xxvi., Nos. 1-3.

Canadian Mining Institute, Montreal. Journal, vol. vi.; Report of Council, 1903; and Indices to Names of Authors, 1891-1903.

Chemical and Metallurgical Society of South Africa, Johannesburg. Journal, vol. iv., Nos. 2-11.

Cory Brothers & Company, Limited, Cardiff. British Coal and Freight Circular and General Export List, August 31st, 1903, to June 30th, 1904.

Cuerpo de Ingenieros de Minas del Perú, Lima. Boletín, Nos. 3, 4, 6, 7 and 9.

Engineering and Mining Journal, New York City. Vol. lxxvi., Nos. 9-27; vol. lxxvii., Nos. 1-26; and vol. lxxviii., Nos. 1-3.

Engineering Times, London. Vol. x., Nos. 3-6; vol. xi., Nos. 1-4; and vol. xii., Nos. 64-77.

Franklin Institute of the State of Pennsylvania, Philadelphia. Journal, vol. clvi., Nos. 3-6; vol. clvii., Nos. 1-6; and vol. clviii., No. 1.

Institution of Mining and Metallurgy, London. Transactions, vol. xi.

Manchester Geological Society, Manchester. Transactions, vol. xxviii., Nos. 8—15.

Massachusetts Institute of Technology, Society of Arts, Boston. Technology Quarterly, vol. xv., No. 3; vol. xvi., Nos. 3 and 4; and vol. xvii., No. 1.

New South Wales, Department of Mines, Sydney. Annual Report, 1903.

— — —, — — —, —. Memoirs of the Geological Survey, Geology, No. 3.

New Zealand, Department of Mines, Wellington. Annual Report, 1903.

— —, — — —, —. Gold-deposits of New Zealand considered in Relation to the Comparative Quantities of Reef and Alluvial Gold of the various Gold-fields of the Colony. By Alexander McKay. Reprinted from the New Zealand Mines Record, 1903. Demy octavo, 75 pages.

Queensland, Department of Mines, Brisbane. Annual Report, 1903.

Queensland Government Mining Journal, Brisbane. Vol. iv., Nos. 38—43; and vol. v., Nos. 44-48.

South Wales Institute of Engineers, Cardiff. Transactions, vol. xxiii., Nos. 5, 7 and 8; and List of Members.

United States, Geological Survey, Washington. Annual Report, 1902-1903.

—, —, —. Bulletin, Nos. 208-227.

—, —, —. Mineral Resources of the United States, 1902.

—, —, —. Monographs, Nos. xliv., xlv. and xlvi.

—, —, —. Professional Papers, Nos. 9-21.

—, —, —. Water-supply and Irrigation Papers, Nos. 65-94.

EXCHANGES.

ıales des Mines de Belgique.
tralasian Institute of Mining Engineers.
ish Association for the Advancement of Science.
ish Society of Mining Students.
adian Mining Institute.
mical and Metallurgical Society of South Africa.
rpo de Ingenieros de Minas del Perú, Lima.
ıklin Institute of the State of Pennsylvania, U.S.A.
logical Institution of the University of Upsala, Sweden.
itution of Mechanical Engineers.
itution of Mining and Metallurgy.
e Superior Mining Institute.
ıchester Geological Society.
ısachusetts Institute of Technology.
ing Society of Nova Scotia, Canada.
al, Geological Survey of the Colony of.
w South Wales, Department of Mines and Agriculture, Geological Survey.
rth-east Coast Institution of Engineers and Shipbuilders.
rue Universelle des Mines, de la Métallurgie, etc.
ıth Wales Institute of Engineers.
ınsvaal, Department of the Mining Commissioner.
ted States Geological Survey.

* No publications received during current year.

July 31st, 1904.

REPORT OF THE COUNCIL OF THE INSTITUTION OF MINING ENGINEERS ON THE COAL-MINES REGULATION ACT (1887) AMENDMENT ACT, 1903, AND ITS EFFECT UPON THE QUALIFICATIONS OF CANDIDATES FOR CERTIFICATES OF COMPETENCY.

The Coal-mines Regulation Act, 1887, section 23 (sub-section 1) provides that (*inter alia*) "no person shall be entitled to a certificate under this Act unless he shall have had practical experience in a mine for at least five years." The Amendment Act, 1903, provides that the above section shall be read and construed as if the words following were added thereto at the end of the said sub-section, namely:—"Or unless he has received a diploma in scientific and mining training after a course of study of at least two years at any University, University College, Mining School or other educational institution to be approved of by a Secretary of State, or has taken a degree of any University to be so approved of, which includes scientific and mining subjects, and has also had practical experience in a mine for at least three years. The approval of the Secretary of State shall be signified in writing under his hand, and may be given subject to such conditions as he may think fit, and may be revoked at any time."

The effect of this section appears to be that the qualifications described reduce the term of five years' practical experience in a mine to three years. Assuming a student to have obtained an approved diploma or degree, he could under the Act sit for examination after three years' practical experience. This would include (*a*) apprenticeship, during which the student must have practical experience; and (*b*) any employment in a mine involving practical experience.

Under section 24 of the Coal-mines Regulation Act (sub-section 2), the Boards for Examinations may (*inter alia*) "from time to time make, alter and revoke rules as to the conduct of

such examinations and the qualifications of the applicants, so however that in every such examination regard shall be had to such knowledge as is necessary for the practical working of mines in that part of the United Kingdom." This provision leaves it in the hands of the Board for Examinations in each district to prescribe their own restrictions and stipulations as to the preliminary qualifications of candidates, a condition of matters which appears to be inconsistent with the fact that the holder of a certificate gained in any district is, by this certificate, qualified to act as manager in any other district. Such an inconsistency points to the desirability of a uniform qualification throughout the United Kingdom. The qualifications at present required in the various districts have been enquired into, and are believed to be as per tabulated statement appended hereto.

From this it will appear that in seven of the districts no special qualifications are insisted on beyond those contained in the Act. In two of the districts, the candidate for a first class certificate must have occupied a post of authority for at least one of the five years, and in two others for at least two of the five years. It would appear that this latter condition must practically nullify the 1903 amendment to the Act.

The Council recommend uniformity in the rules as to the qualifications of the applicants throughout the Kingdom. They suggest, for the first class certificate, five years' practical experience in a mine under the Coal-mines Regulation Act. Apprenticeship to a mining engineer, during which the applicant has practical experience in a mine, may replace the above whole or in part, and an approved degree or diploma may be substituted for two of these years.

The Council do not consider it to be essential that the candidate should have held any position of authority.

The Council recommend that the printed questions for the written portion of the examinations shall be identical throughout the Kingdom, that the examinations shall be held throughout the Kingdom at the different centres on the same day, at intervals of not more than 6 months, and that the examination papers shall be prepared by a Central Committee consisting of one Examiner from each of the Boards for Examinations.

ıe Council further recommend that the subjects for ination, throughout the Kingdom, should be as follows: —

'or the first class certificate:—

1. Arithmetic, including decimals and mensuration.
2. Mechanics: general principles, including strength of materials. Electricity: elementary principles.
3. Geology.
4. Practical mining, including methods of sinking, working, timbering, ventilation, and the mechanical and general engineering of mines.
5. Surveying and plotting.
6. Coal-mining legislation.
7. Ambulance.

An approved degree or diploma may qualify in Nos. 1, 2 and 3 subjects, without further examination therein.

For the second class certificate:—

Five years' practical experience in mines under the Coal-mines Regulation Act.

The subjects for a second class certificate to be as follows:—

1. Arithmetic, including vulgar fractions.
2. Practical mining, including methods of working, timbering and ventilation.
3. Elementary surveying.
4. Coal-mines Regulation Act and Special Rules.
5. Ambulance.

The Council deprecate making the theoretical portion of this examination too severe.

The minimum age for examination for either class to be, as at present, 23 years.

As regards the meaning and mode of application of the 1903 Amendment Act, the Council learn that a private report has been made on this subject to the Home Secretary by special experts. The Council desire, however, to call attention to the following points:—

It appears that neither the diploma nor the degree specified in the Act is to be recognized, unless it includes a minimum of

actical experience in mines, so as to give reality to the teaching the mining subjects. This is, no doubt, wise; but, in view of e fact that no university degree can be taken in less than ree years, while the diploma can be taken in two years, it ould be well to allow any time thus spent underground to count wards the time recognized under the Coal-mines Regulation ct in the case of a degree but not of a diploma: thus bringing e time required for each of these more nearly on a par, and nding to encourage students to take the degree rather than the ploma, as the Council consider three years none too much obtain a proper knowledge of the scientific side of the mining ofession.

The Council also agree that evening-class work should not allowed to rank for either a degree or diploma, but that udents working for these should give the whole of their time their college work. At the same time they would be glad see evening work followed by the successful passing of an amination recognized to a limited extent for the second class rtificate; it might, for example, pass the holder for Nos. 1 and subjects in the examination.

The Council recommend that the nature of the degree or iploma be in every case stated upon the face of the qualifying olliery manager's certificate.

September 14*th*, 1904.

ABSTRACT OF REGULATIONS OF VARIOUS BOARDS FOR EXAMI...

Name of District.	First Class Certificates. Age in all Cases not to be less than 23 years.		Second Class Certificates. Age in all cases not to be less than 23 years.
	Qualifications Required.	Equivalents Accepted.	Qualifications Required.
East Scotland ..	Five years' practical experience in a mine.	Apprenticeship to a mining engineer, if the apprentice has to go down mines and obtain practical experience therein.	Same as for first class.
West Scotland..	Practical experience in a mine for at least five years.	Apprenticeship to a mining engineer cannot be substituted, unless the apprentice has regularly to go down mines and obtain practical experience therein.	Same as for first class.
Newcastle-upon Tyne	Actual practical experience for at least five years as under-manager, under-viewer, assistant-viewer, fore-overman, back-overman, master-shifter or master-wasteman.	Two years' or three years' apprenticeship to a mining engineer, with evidence that such period afforded sub-tantially practical experience in a mine (for an equivalent period.)	Practical experience in a mine for at least five years as for first class, or as deputy-overman, or practical working miner.
South Durham .	Actual practical experience for at least f ve years as under-viewer, assistant-viewer, fore-overman or back-overman.	Articled apprenticeship as above.	Practical experience in a mine for at least five years as for first class, or as deputy-overman, master-shifter, master-wasteman, or practical working miner.
Manchester ...	Five years' practical experience in a mine.	None.	The same as for first class, suitable for practical working miners.

	coal-mining.		
Yorkshire .	Practical experience in a mine for at least five years.	A period of apprenticeship to a mining engineer cannot be substituted, unless the apprentice has to go down mines and obtain practical experience therein.	Same as for first class.
Stafford	Practical experience in a mine for at least five years, during which, for at least one year, the candidate has been employed as under-manager, overman or overlooker, or some similar post.	None.	Not less than five years' practical experience in a mine.
Cardiff	Practical experience in a mine for at least five years, during which, the candidate has been employed for at least one year as under-manager, overman, day- or night-fireman, or second class certificate holder	Apprentice to a mining engineer for three years or upwards. If practical experience in a mine has been obtained, this is considered equivalent to second class certificate.	Actual experience in a mine for at least five years.
Midland ...	Regularly engaged in connection with actual colliery management.	None.	Practical experience in a mine for at least five years.
Southern ...	Five years' experience of colliery operations, of which at least two years at general underground work. Plan and section of strata made by candidate to be shewn.	None.	Five years' experience of colliery operations, of which at least two years at general underground work, and experience in working in coal-faces.

COAL-MINING IN ASTURIAS, SPAIN.

By Prof. HENRY LOUIS, M.A., A.R.S.M., F.I.C., F.G.S., etc.

The province of Asturias is, as is well known, the most important coal-mining district in Spain, its annual output amounting to some 1,500,000 tons. One of the most important coal-fields is that traversed by the river Nalon, which, rising among the northern flanks of the Cantabrian mountains, flows swiftly in a northwesterly direction. Numerous coal-seams crop out along the precipitous sides of its valley, the ruggedly mountainous contours of the country facilitating their attack by means of day-drifts or adit-levels, to such an extent that shafts and pumping-engines are almost unknown. The coal from this field is conveyed to its natural harbour, Gijon, by means of the Langreo railway that follows in great part the narrow strip of flat land in the bottom of the Nalon valley; it starts from the small village of Pola de Laviana, about 30 miles from Gijon, is a single line, and is remarkable for the fact that about midway between the terminal stations the line is replaced for a distance of about 1¼ miles by a self-acting incline. The port of Gijon is equipped with staithes at which vessels of moderate tonnage can be conveniently loaded.

The coal-measures in the above field consist of alternations of firm shales, sandstones of moderate hardness, and limestones, with numerous coal-seams, usually from 2 to 6 feet in thickness, lying at steep angles ranging from 30 to 60 degrees to the horizontal, these strata constituting the lowest members of the Carboniferous formation. The coal is a good bituminous coal, and fairly hard and clean.

The mine selected for description is one of the smaller mines of the district, and is situated near the village of Pola de Laviana, the methods of working being somewhat more primitive than those in use in some of the larger collieries. Owing to the

Spanish laws which control the granting of mining concessions, it is usually difficult to secure large royalties, and the one in question contains only some 2,300 feet (700 metres) along the strike of the seam by 2,300 feet (700 metres) across it. There are two workable seams, only one of which is being worked at present, the total amount of coal existing in the royalty being estimated at about 1,000,000 tons. The seam being worked averages about 3 feet in thickness; it pinches to about 1 foot in places, but in others it is fully 4 feet thick; the floor consists of a hard fire-clay, and the roof of a firm, strong shale, that stands well as a rule, but is treacherous in places, tending to come away from a thick bed of sandstone, some 26 feet above it. The other seam averages 2½ feet in thickness, has a very bad roof, and is 200 feet below the first named. The dip is 30 to 35 degrees to the north-west.

The mine that is being worked is opened up by means of five drifts, running south-westward into the hillside, practically level; these drifts are about 100 feet apart vertically, or about 200 feet along the dip of the seam. The lower levels are worked first, and the upper ones are started successively as the lower ones advance; only the fourth and fifth levels (from the bottom) are now being worked. The drifts are run close under the roof-shale, the stone cut down on the high side being used to build a rough pack on the lower side of the drift. Where the roof is good, the drift is timbered by single props along the high side, which are hollowed to receive lids of round timber shaped to the slope of the roof (Fig. 1, Plate XIII.); where the roof is bad, sets, consisting of two legs and a cap, are put in. Small inclined shafts 5 feet wide are put down in the seam from the surface, say about 330 feet apart, for the purpose of ventilation; these form upcasts, the air entering by the various levels.

The seam is thus blocked out by these levels into horizontal pillars or slices about 200 feet wide along the dip; rises are put up from each level, and the face thus formed is attacked by a method of working which may be described as intermediate between longwall and overhand stoping. A pillar, 10 feet wide, is left to form the roof of the level, and a similar one to form the floor. The former has small passes, about 5 feet wide, driven through it 26 to 33 feet apart, and these passes are fitted with wooden shoots at such a height as to deliver the coal into tubs

standing upon the railways in the levels. These shoots are closed by planks that can be removed whenever tubs are to be filled. The roof-pillar having been left, a stope-drift, forming a place 10 feet wide, is driven out above it, and then places or stopes measuring 11 feet along the dip, and leading each other by about 13 feet in the direction of the strike, are successively set away parallel to the main levels. Half-way between the two drifts, a stope-pillar 6½ feet wide is left to support the roof, passes being driven through it to correspond with those in the roof-pillar of the drift. The arrangement is shown diagrammatically in Fig. 2 (Plate XIII.), which is a plan in the plane of the coal-seam.

There is one hewer to each place, who kirves the coal on the 11 feet face (that is in the direction of the strike), to a depth of 4 to 5 feet, and then puts a shot-hole in the 13 feet or long face above the end of the kirving about half-way up the seam, to a depth of 5½ to 6½ feet, this being also the length of the kirving, as shown in Fig. 3 (Plate XIII.), which represents a plan of two places in the plane of the seam. The holes are put in with long steel-drills, having a cutting edge about 1¾ inches broad, and single-hand hammers; machines seem to be unknown. The holes are charged with black-powder costing about 10d. per pound, and the shot brings down the kirved portion in fine large lumps. This work takes the morning shift, from 7 a.m. to 11 a.m.; the men come in again for an afternoon shift, from 1 p.m. to 5 p.m., in which the other half of the place is kirved and shot down. Before commencing to kirve, the hewers set any props that they may consider necessary; these props are of beech, oak or sweet chestnut, 6 to 8 inches in diameter and placed 5 to 6½ feet apart. They cost about 4d. each. The hewers are paid 3 pesetas (about 2s.) per metre (3¼ feet) advance of their places (11 feet long), and as the advance is about 4 to 5 feet per day, their average daily earnings are from 4 to 5 pesetas (2s. 8d. to 3s. 4d.), the day's work producing 4 to 5 tons of coal, so that the hewing price may be averaged at one peseta or 8d. per ton. Rather higher rates are paid for narrow work such as the stope-drift, for working under the stope-pillar, or the floor-pillar, for the passes, etc.

The roof above the worked-out portion is left standing on the props, which are renewed as they fail for a distance of quite

feet back from the face; of course, ultimately it falls in, it is so strong that it stands for a long time. No attempt ıade to draw any of the timber, nor is any stowing done, ɹpt incidentally when stone from the advancing drift or from workings has to be disposed of. The cost of timber is said ɐ about 2½d. per ton of coal.

The output of the mine is about 50 tons of coal per working but exceptionally up to 70 tons per day have been produced. Only natural ventilation is employed, and no means appear ɔ used to direct the air-currents; the latter are feeble, but ɐɹ to be sufficient. No gas has ever been seen; the levels tolerably damp, but the working-faces are comparatively the coal does not, however, make much dust. Naked oil-ɯs of the universal Spanish pattern, fed with olive-oil, are ɹwhere used, one or two safety-lamps being occasionally lɔoyed for testing purposes.

The slope of the seam is just too flat for the coal to slide ɐ without assistance; it is therefore shovelled down along floor by lads who guide it through the passes to the shoots ɐ referred to. Other lads fill the tubs, which hold about ɯts., and put them by hand to self-acting inclines close to mouth of the drifts. There are two or three lads to each ɹɹ, and their wages average about 2 pesetas or 1s. 4d. per

The various drifts are connected externally by short self-ᵷ inclines, and a tub coming from one of the upper levels ɔo be put by hand from the end of each incline to the head ɹe next, all this work being done by lads.

The tubs are trammed from the bottom of the lowest incline ɹe head of an inclined wire-rope-way, where the coal is ɔd into rectangular rope-way buckets, furnished with drop-ɹms; by means of this rope-way the coal is carried to a ɐry on the banks of the river Nalon. The coal is delivered ɔ a fixed inclined screen, made of round bars about 1 inch ıameter and 1½ inches apart. All coal that does not go ıgh the bars is classed as lump coal *(grueso)*, and is loaded ɐnd into railway-wagons. All that goes through the screen ɐshed by hand in two strakes, each, say, 30 feet long by ɹches wide and deep. The dirt is raked out at the head ɐ strakes, and the coal escaping at the lower end is riddled ɐ screen made of plates punched with holes about ½ inch in

diameter, thus forming two classes, namely, nuts *(galleta)* and smalls *(menudo)*. No attempt is made to collect the slimes, of which considerable quantities are washed into the river. The percentage proportions obtained are about as follows:—Lumps, 40; smalls, 30; nuts, 20; and dirt and loss, 10.

There are five women and eight men and lads engaged at the washery, including those loading the wagons. The washery is connected with the sidings of Laviana station on the Langreo railway by a small branch line some 1,000 feet in length.

The average cost of the coal, everything included, in railway-wagons, is said to be about 8 pesetas or 5s. 4d. per ton, and this figure seems to agree fairly well with the data already given. The selling prices, per ton, on rail at the mine, are said to be as follows:—Lump coal, 24 pesetas or 16s.; nuts, 23 pesetas or 15s. 4d.; washed smalls, 18 pesetas or 12s.; and unwashed smalls, 12 pesetas or 8s. It will be seen that whatever criticisms may be directed at the technical aspects of Asturian coal-mining, its financial results can only be regarded in this country with feelings of profound envy.

In a neighbouring and larger colliery, producing about 200 tons per day, the slimes from a washery, identical in other respects with that described, are collected in settling boxes and slime-pits. These coal-slimes are coked in heaps, something like the method of making charcoal, the heaps being about 70 feet long, 7 feet high, 15 feet wide at the base and 10 feet wide on the top. A bed of slimes is laid on a level piece of ground, and well pressed down: upon this logs of wood about 8 inches in diameter are laid stretching half-way across the bed, at right angles to its longer sides, and about 6 feet apart, the logs at the opposite sides alternating with each other. At the inner end of each log, another log is then set upright, and the slimes are rammed around these logs until a heap of about the above dimensions is produced. The outside of the heap is well consolidated by beating with the blade of a shovel, and the logs are then withdrawn, leaving a series of short horizontal flues, each communicating with a vertical one. The heap is then fired, commencing at one end, by placing burning coals in the horizontal flues, and the fire is gradually carried along the heap, being damped when it has burnt long enough by covering the heap with earth or coke-dust. Such a heap takes about 14

ı to burn, and is then tightly sealed up with dirt, coke- or ashes, and left for another 3 days. It is then taken n, and the red-hot coke quenched with water. By this iitive method of coking, a rather poor coke is made from a ıgly-coking coal, and at least 30 per cent. of the coal is burnt aste. The method is merely interesting as a survival of imitive system; in other districts of Asturias, for instance, Lieres, it may still be seen in operation side by side with product coke-ovens.

Ir. BENNETT H. BROUGH (London) said that the reference in paper to olive-oil as an illuminant, reminded him that many s ago, when he was making a survey in the north of Spain, the ager of some metal-mines there informed him that the use ive-oil was one of the principal items of expenditure, because miners would insist on drinking it, and notwithstanding the tion of petroleum and other mixtures the oil continued to ppear at the same extravagant rate. He believed that it was ct that in that part of Spain every miner had in his house a : of oil which he used indiscriminately for his lamp, his hair his dinner.

Ir. M. H. MILLS (Mansfield) asked whether any calculation been made as to the area of coal in the Asturias. The paper of interest, as there was a large deposit of iron-ore close to coal-field, and if there was a considerable area of coal suit- for coke-making there could be no doubt that ironworks ld be speedily erected there to compete with our own.

Ir. C. B. PALMER (Pelaw-upon-Tyne) wrote that in 1890 he ed several of the collieries described by Prof. Louis in his esting paper, but at that time the coal-field was only just g opened out to any extent, although he believed that coal- ing was carried on in this district and in the province of ı in the time of the Romans. Fourteen years ago the our of Gijon was very shallow and only small coasting- ners could enter, large ocean-steamers being loaded and arged by means of lighters outside the harbour, and as e was little shelter outside, this was impossible at times. aps the harbour had been deepened since that time.

ne railway from Gijon to Laviana used to be the norm al
sh gauge, which is 18 inches less than the gauge univers al
pain; this caused considerable difficulty in transhipping co al
n narrow-gauge to wide-gauge trucks at Gijon for despat ch
inland towns. He believed that this railway was one of the
st, if not actually the first, to be constructed in Spain, and the
assenger-carriages showed that they came from Great Brita in.
he incline, near the town of Sama, was not self-acting, as the
veight of the descending was not sufficient to haul up the ascen d-
ing train, and a stationary engine at the top of the incline was
used to assist. The trains were mixed (goods, minerals and
passengers), but on the incline the mineral and goods portion was
hauled up separately from the passenger part.

In 1890, the most important collieries were at Ujo, in the
adjacent valley to Laviana. These pits belonged to one firm,
and were connected together by a narrow-gauge railway; he
saw some good hauling-engines, which were in marked contrast
to the haulage by oxen, which existed in the mines at Sama.

There was a rich cinnabar-mine at Mieres, and in the same
mine were found thin seams of coal. The coal was, however, of
not thick enough to work. At Mieres ironworks, the iron-ores of
Asturias and Bilbao were mixed, the former not being so rich a
as the latter. There was an immense quantity of pure silica e
at Sama, which was quarried for the Douro ironworks. The by
great obstacle to the opening out of these mines was the scarci e
of labour, most of the inhabitants being agricultural labourer
and the emigration to South America took away the surplu
population.

At Ujo, the seams were steep enough to allow of the co
sliding down from the face to the shoots, where it was loaded
the underground levels into trucks, the coal being guided dow
by means of planks nailed to the props supporting the ro
In some of the mines where the roof was not good, intermedia
levels were driven to cut off bad ground; these levels were
driven out to the day as were the other main levels.

He believed that there was a great future before the Asturi
as the province was rich in minerals of all kinds, but transp
was bad and costly, and capital was wanting to open out t
mines so as to make them profitable concerns.

At present, British coke for the Bilbao blast-furnaces co

ompete with coke made from Spanish coal, as the steamers from he Tyne and Tees ports took out coke and returned with iron-re from Bilbao; but when the Bilbao ore became exhausted, here was reason to believe that the ironworks in the north of Spain would be supplied with both coke and iron-ore from the Gijon district.

Mr. J. A. JONES (Gijon) wrote that Prof. Louis' paper on coal-mining in Asturias was of interest to one who had resided n the province for the past 25 years, and had been actively ngaged in the working of coal during a portion of that period.

The total output of coal throughout the province during 1903 mounted to 1,424,877 tons. With the exception of one mine, vorked at Arnao by the Royal Asturian Company, producing 56,000 tons for the supply of their zinc-works there, worked by pit (and the workings had been carried on for some 2,000 feet nder the Bay of Biscay), the whole of the working throughout he province without any other exception was carried on by day-drifts, and the system of getting was that described in the paper.

The Langreo railway started, as was stated, from Pola de Laviana, distant 32½ miles from Gijon harbour. The incline nentioned was not self-acting, but was worked by a massive louble-cylinder engine, with a single drum, 12 feet in diameter, which was brought from Great Britain in 1850. It had had one of the cylinders replaced since it was first erected, but otherwise t was as good as ever. Probably this was one of the reasons why he company did not decide to vary the line, in order to do away with the incline, which was costly and slow, and it limited he transport of the railway to the quantity that could be passed over it; but competition by the railways already constructed nd in course of construction would shortly compel the Langreo Railway Company to move ahead. The variation would not be costly; and they had the money to do it, as well as the Govern-nent concession.

The tidal port of Gijon, as it exists to-day, has three balance-staiths, erected also in 1850, and one 30 tons gantry-crane for shipping coal. This position will soon belong to the past, as a new deep-water port is in course of construction and well advanced, and will be ready for shipping coal and iron-ore within about 18 months. It will be fitted with the most

improved appliances for cheap and rapid loading. The connection of the four railway-lines will also be ready at the same time.

As the Asturian coal-fields have an area of over 460 square miles, made up of eleven distinct known basins of different altitudes in the Coal-measures, it may be stated that the whole of the series are represented, from the anthracite upwards, by a distinct flora and fauna and the different qualities of the coal found in each.

Confining these remarks, however, to the principal Coal-measures, its representative flora comprises *Sigillaria, Calamites, Lepidodendron, Sphenopteris* and *Pecopteris*, and this fixes it as being equivalent to the Middle Coal-measures of South Wales. These measures occupy about 350 square miles of the whole area, and the quality of the coal is shewn by the following results of Admiralty tests, carried out in the Ferrol Arsenal:—

Physical characteristics: colour, brilliant black; composition, compact lamellar; and lustre, resinous.	
Hygrometric water absorbed in 24 hours	1·82 per cent.
Water and hydrocarbons eliminated at 100° Cent. ...	2·46 ,,
20 pieces of coal, weighing 20 kilogrammes, placed in a drum, and revolved 90 times in 3 minutes, produced of small...	12·50 ,,
Density, average	1·273.
Coal consumed from the commencement of ebullition to the termination of the trial at the end of 3 days	**1,502·5 kilos.**
Water evaporated during the test	**11,802 litres.**
Time occupied	**15 hours.**
Water evaporated per kilogramme of coal	**7·856 litres.**
Ash obtained	**1·68 per cent.**
Clinker obtained	**0·402 ,,**
Siftings obtained	**6·158 ,,**
Soot obtained	**0·398 ,,**
One gramme of coal to 30 grammes of litharge produced a bead of lead weighing	**27·853 grams.**
Equivalent in calories...	**6,619·26.**
One gramme of soot with the same quantity of litharge produced a bead of lead weighing	**10·27 grams.**
Equivalent in calories	**2,588·302.**

There is a remark, respecting the Spanish laws which control the granting of mining concessions, that requires some elucidation. There is no difficulty whatever in acquiring concessions, always provided that there is free ground: that is, land that is not occupied by other pre-existing concessions; but any ground thus taken must have a minimum area of 4 hectares (9·88 acres), there being no limit whatever to the number of hectares above

that may be applied for to form a mine in free ground. cle 11 of the law of December 29th, 1868,* provides that rsons can obtain any number of unities for one concession, ys provided that this number be more than four. The whole ie unities, which, when united, form a concession, should be ıped without solution of continuity so that the contiguous will be joined in their whole length to any one of the sides." ı unity is defined in Article 11, which enacts that "the unity ıeasure for mining concessions relating to substances of the nd and third sections is a solid having a square area with a of 100 metres, measured horizontally in the direction gnated by the petitioner, and for the last substances of indefi- depth. For the first, the profundity terminates where the xable material becomes exhausted." The relatively small s are due to the supineness of the applicants at the time of ying for the concessions, limiting them by the extent of their ets, to avoid royalty-payments to the Treasury, and before make up their minds to make further applications for r increased concessions, others step in and apply for the ining ground, so that their procrastination brings about the of any opportunity to increase their holdings, other than by hase. However, there are several companies who own large iguous properties of the extent of several thousands of ares.

The mine selected for description was well known to him (Mr. s), and instead of two, it contained five coal-seams, three of h were still untouched. He had had an opportunity of ing the existence of these by surface-scratching on their rops, some years ago, and they were between 3 and 4 feet k, parallel to the two seams described in the paper.

The details given respecting the working and tramming are ect for all the collieries, but, of course, those respecting the hing and classifying, as given, only apply to a very few. The t advanced ones are fitted with machinery and plant of ian and French make for washing and sizing. Railway- ngs receive in the trucks the various sizes. The screens the lump coal. What passes through these is conveyed he washers, which produce nuts or house coal (*galleta*), grain (*granza*), that is, grains of from 0·12 to 0·40 inch (3 to 10

* *The Mining Laws of Spain*, 1904, translated by Mr. J. A. Jones.

millimetres) across, and small (*menudo*), with slime-pits and slimes in these collieries go to the coke-ovens or to the fuel-works. The coke-ovens are of the Appolt, Bernard, Carvé and Coppée systems; there is not a single beehive coke-oven.

Smalls

The official statistics of the yearly output of the principal collieries show that their daily production is 980, 890, 686, 380, 320 and 256 tons respectively. The whole of these are fully equipped with washing-plant and coke-ovens, and four of them have also fuel-plant.

In small collieries, the small coal passing through the screens is shovelled by women into jig-boxes; there are two women to each jig, and one jig to each screen, and as many screens as are necessary for treating the output of the mine. The jig consists of a box with two unequal compartments, the dimensions of the box being 9 feet long, 3 feet 3 inches wide and 3 feet deep. The small-coal compartment measures 2 feet by 3 feet. A frame consisting of two squared uprights and a crosspiece supports the longitudinal plunger-handle, which extends beyond the longer compartment, where the woman stands to work it. The larger compartment has a loose frame fitting into it, supported in its position by ribs of wood nailed on to the inside of the compartment. This frame has a bottom of coarse wire-cloth, or wattle made of twigs. One woman shovels the coal from under the screen into it, the other jigs the handle, alternating hourly at the work. By jigging, the coal comes to the surface, while the waste, of stone or shale, settles on the bottom. The clean coal is shovelled from the frame on to wheelbarrows or trams, and conveyed to wagons or put into stock. The operation is repeated, until there is a bed of refuse on the bottom, which is cleared off to the rubbish-heap, and work is again started in the same way. The slimes and fine dirt fall to the lower portion of the box, and are scoured out as occasion requires. With this method no slimes are saved, and owing to this and the coal remaining with the bottom dirt on the jig when this is cleared away, it is very wasteful. Two women with one jig produce about 6 tons of clean small coal per day: they are paid 1s. 4d. (2 pesetas) each per day.

Mr. F. Coulthard (Remolinas, Spain) wrote that, like Prof. Henry Louis, he had been struck by the primitive mode of work-

ing many of the coal-mines, whilst almost alongside other mines are being worked by up-to-date machinery. At the port of Gijon, a deep bore-hole was put down to ascertain whether the coal-seam (as it most probably does) reaches there, but he did not know the result. In addition to the district described by Prof. Louis, there was the Mieres coal-district, from which a railway was being made to the port of San Esteban, passing the Government arsenals at Trubia and Grado on its way. Again, from the railway-station at Trubia, a narrow-gauge railway was being constructed to Teberga, where new coal-mines were being opened, whilst it was rumoured that a new railway was to be made from Grado to Gangas de Tineo, where the Coal-measures cropped out. This line was also intended to bring down timber for the mines; it would pass the iron-ore royalties of Sala, which, owing to the distance from communications, were at present unprofitable and only slightly worked.

To the east of the Nalon valley and in the direction in which he new railway joining Infiesto with Santander was being made, oal was also being sought. He had seen where some had been orked, and a shaft was being sunk to cut the seam at a greater pth. The greatest difficulty in working these seams was the d roof and the faulted nature of the ground.

The Asturias are rich in minerals; in the Picos de Europa re is zinc; at Orlignera and round about, copper, and a water-k etted furnace has been erected; at Covadonga, manganese; Laviana, coal, copper- and iron-ores; at Mieres, coal and ic ksilver; between Mieres and Trubia, copper- and iron-s ; at Lalas, iron-ore; at Tineo, plumbago; and at Gangas Tineo, coal, iron-ore and gold. Nearer the shore, there is n-ore near Infiesto in the hills; siliceous iron-ore near ijon is mixed with ore from Bilbao and smelted; the gold-earing rivers, etc., near Navia; near Ribadeo, magnetic iron-re and carbonate, and lead.

The principal drawbacks to the Asturian coal-industry are the heavy railway-freights and the want of rolling-stock, which allow British seaborne coal to compete at a very short distance from the mines, although Asturian washed coal gives better results than Newport coal.

A short while ago, an explosion of gas occurred in a mine near Mieres, causing death, and another in the coal-mines at Villanueva.

The CHAIRMAN (Mr. J. C. Cadman) moved a vote of thanks to Prof. H. Louis for his paper.

Mr. M. WALTON BROWN seconded the resolution, which was cordially approved.

Prof. H. LOUIS, in acknowledging the vote, said that at the mine described the men had to provide their own oil, so that it was immaterial to the management to what use they put it. The paper only described the method of working a particular mine, as he had not seen sufficient of the district to deal with the methods of working as a whole. Iron-ore mining in that district had been already described by Mr. Jones in two papers; but, personally, he did not believe that the ores offered a future for a large iron-industry. He was confirmed in that opinion by the fact that three local blast-furnaces had found it advantageous to import iron-ore from Santander and Bilbao to mix with local ores.

He was much obliged to the members who had contributed to the discussion and had added much miscellaneous information respecting Asturian mining: his own paper had, of course, reference only to the details of the mode of working one specific mine, which was, however, fairly typical of the local practice. He noted that both Mr. C. B. Palmer and Mr. J. A. Jones objected to his calling the Langreo incline, a self-acting one. The incline was, as these gentlemen stated, equipped with a powerful hauling-engine; on the other hand, on the day that he travelled over the line the trains were composed, about half of passenger-carriages and half of mineral-wagons, these loaded with coal going down to Gijon, whilst the ascending train carried the empty vehicles. The trains were divided into two sections on the incline, each section made up of passenger-carriages and mineral-wagons, the load in the latter being sufficient to bring up the corresponding section with empty wagons. He was informed that this was the usual practice (he himself had only travelled once over this line) and that the hauling-engine was never used unless there happened to be a shortage of coal going down or some very heavy goods coming up. He supposed that, technically, the correct description of the arrangement would be "a self-acting incline, with an auxiliary engine."

He agreed that Mr. J. A. Jones had correctly stated the Spanish mining law, and that the law prescribed no limits to the area of mining concessions that one individual could take up. Nevertheless, in practice, the result was that the royalties were, generally speaking, quite small, although there were exceptions.

Mr. GEORGE FARMER read the following paper on "The Problem of Gob-Fires":—

THE PROBLEM OF GOB-FIRES.

By GEORGE FARMER.

Introduction.—While the occurrence of a gob-fire, or, in fact, any underground fire, is one of the worst evils with which the mining engineer has to deal; out of many dangers, it is, perhaps, the one danger that he most dreads and wishes to avoid; yet it is a subject on which there is much difference of opinion: the cause of gob-fires being a matter upon which neither mining engineers nor chemists are agreed. It will be readily admitted that gob-fires are a great source of danger, and the labour attending their removal is very difficult, owing to the presence of poisonous and explosive gases, and to the tendency of the fire to spread and produce greater heat. The loss to property may, in some cases, be considerable, not merely from the actual destruction caused by the fire, but from the fact that the destruction may demand the isolation of a large area of workings, which, in most cases, implies a diminution of output. In any event, great anxiety is thrown on the management by the outbreak of such fires.

Dangers.—The average death-rate due to gob-fires has not been great at any period; this, however, is probably due to the careful arrangements made by mining engineers in dealing with them. The majority of deaths arising from gob-fires are due to suffocation, or poisoning, by the gases produced; but it should be remembered that the effect of a fire in a coal-mine is to generate explosive gases, the properties of which are well-known, and consequently the management of a colliery in which a fire occurs must be on the alert against the contingency of an explosion. The presence of these gases, accompanied by great heat, perhaps constitutes the chief difficulty in dealing with gob-fires, and in the recovery of a mine after an explosion.

Theory of the Reactions.—There seems to be much difference of opinion as to what reactions actually take place in the course

f a gob-fire, and the nature of events, and the gases given off, ıust, therefore, be a matter of conjecture. The writer has ad several years' experience in the management of gob-fires, ut in making observations as to the reactions set up, he finds ıat he must connect certain well-worn theoretical standards ith his practice to arrive at, what he is bold enough to call, standard principle. The aim of this paper, therefore, is to ıdicate broad principles, rather than to discuss the particular ıanner of their application to local cases. Some of the positions ɔcupied in the paper may not be quite impregnable, but the riter believes that they are worth reconnoitring, if only for ıe sake of arriving at some standard principles dealing with subject that seems to tax the ingenuity of the mining engineer ı devising means of prevention and cure.

For the purpose indicated, the writer intends to deal xclusively with spontaneous combustion, and the problem of ob-fires.

From the earliest stages of science, the mining engineer, ı common with all other professional men, has been taught ıat, in the whole universe, so far as it has yet been explored, ıere are but two entities, namely, matter and force. He has een taught that each of these entities is indestructible; that he forms of matter may change and the forms of force may e altered; that under all known conditions, the total amount f matter in the whole universe is always a constant quantity; nd that the total amount of force is always invariable. .ctual experiment fails to determine that there is a limit to ıe divisibility of matter, but the experimental and theoretical eaching of chemistry leads to the belief that all bodies are ıade up of minute and indivisible particles to which the name f atoms is given. The indestructibility of matter is sufficiently ɔroved by the fact that the quantity of matter taking part in ıy change is measured by its weight, and the total weight of matter taking part in any change (physical or chemical) is ɔqual to the total weight of matter produced by the change. The mining engineer, therefore, in common with others, holds certain standard theories, which the writer will discuss.

(1) The Atomic Theory.—The atomic theory asserts, on its practical side, that all kinds of matter are made up of indivisible

particles called atoms, and that the atoms of the different elements have different specific weights. It would appear therefore that three laws of combining proportions are asserted:—(*a*) The law of combination in constant or definite proportions, teaching that, in every chemical compound, the proportion and nature of the constituent elements are definite and invariable: thus water invariably consists of 8 parts by weight of oxygen to 1 part by weight of hydrogen. (*b*) The law of combination in multiple proportions, teaching that the several proportions in which one element unites with another invariably bear towards each other a simple relation; thus 1 part by weight of hydrogen unites with 8 parts by weight of oxygen to form water; and with 16 parts (that is, 8×2) parts of oxygen to form peroxide of hydrogen. (*c*) The law of combination in reciprocal proportions, teaching that the proportions in which two elements combine with a third also represent the proportions in which, or in some multiple of which, they will themselves combine; thus, in olefiant gas, hydrogen is present with carbon, as 1 to 6; in carbonic oxide, oxygen is present with carbon as 8 to 6; and in water, hydrogen is present with oxygen, as 1 to 8.

(2) Chemical Action.—When any two or more elements are brought into contact, under proper conditions, they may unite and form chemical compounds of greater or less complexity, in which the constituents are held in union by a form of energy, which has received the name of chemical affinity. This affinity is characterized by its acting between dissimilar particles, and producing a new kind of matter, which is readily distinguishable from either of the substances combining to form it, and cannot be again separated into its elements by any merely mechanical process.

This act of chemical combination, governed by the laws of combining proportions abovementioned, is attended by the evolution of heat, that is, bodies become heated in consequence of combination taking place, then follows combustion caused by the chemical combination of the burning body with the oxygen of air.

(3) Conservation of Energy.—By the investigations of Prof. J. P. Joule, and others, into the nature and phenomena of heat

ınd the discovery of the equivalence of a definite quantity of nechanical energy to a definite quantity of heat, the grand ırinciple of the conservation of energy was established. This ısserts that the total amount of energy in the universe, or in ıny limited system which does not receive energy from without, or part with it to external matter, is invariable. If energy f any form seems to disappear in such a case, it reappears in ome other form. Thus, mechanical energy is convertible into ıeat, and heat may be converted into the potential energy of hemical separation; again, the energy of chemical separation s also convertible into heat. Connected with this principle is ınother which states that no known natural process is exactly eversible. From the principle of the dissipation of energy, t is found that, although work can be easily converted into ıeat, all the heat cannot, by any known process, be converted ıgain into the form of work. In consequence of this law it is ıeld that the mechanical energy of the universe is becoming ıvery day more and more changed into heat; and so science ooks forward "to an end when the whole universe will be an ıqually heated inert mass," and from which every thing like ife or motion or beauty will have utterly passed away. Nothing vill be lost, only changed; the molecules will remain the same, ncapable of growth or decay, of generation or destruction.

Spontaneous Combustion.—Having the abovenamed theories rmly impressed on his mind, the mining engineer should find o difficulty in framing a satisfactory theory to account for ob-fires; for, given the necessary elements, chemical action teps in and unites them in their own combining proportions, nd heat is evolved. This heat may not be sufficient to cause ombustion, but by the aid of mechanical energy more heat is volved, until finally the temperature of ignition is reached, and re is certain. The general question of spontaneous combustion ın have for the mining engineer but a general interest; while ıe question of spontaneous combustion in that particular aspect nown as gob-fires has an especial interest for him; and thus ıe problem of gob-fires becomes a purely mining question. pontaneous combustion begins with oxidation. Bodies exposed ı air slowly combine with the oxygen, and this combination or xidation is accompanied by slight increase of temperature.

Combination with oxygen continues and the temperature rises, and as the temperature rises the combination with oxygen becomes more rapid and hence the temperature rises more rapidly. Eventually, the temperature becomes so high that the point of ignition is reached, and the body bursts into flame.

It would appear from this that there are three necessary conditions required for spontaneous combustion, namely: A supply of combustible material, a supply of oxygen, and a proportionate amount of initial heat. In many cases of spontaneous combustion, it is often difficult to discover whence the necessary amount of initial heat had been derived; while in others, it is just as difficult to explain whence came the necessary oxygen. In the case of gob-fires, however, neither of these difficulties are presented; for oxygen is always present, combustible material is also present, and a study of the conditions of the abovenamed theories supplies the source of the necessary initial heat. It may be argued that all seams are not liable to spontaneous combustion, but as all seams are composed of combustible material, it is only when other conditions are not available that it can be said, not that the seam is not liable to gob-fires, but that the conditions of the mine are not suitable for spontaneous combustion. The reasons are found either in the conditions of working the seam, or in the natural conditions of the strata, or in the position of the seam.

Conditions.—It may not be out of place here to study the necessary conditions of a mine liable to gob-fires, and to eliminate from them their respective positions.

(1) There is no lack of combustible material, as in nearly every mine combustible material is present in the form of coal, or a carbonaceous shale; or in the form of a quantity, more or less, of broken and apparently irrecoverable timber, either accidentally, purposely, or carelessly left in the goafs. Again, the material may be supplied in the form of brasses, or batts found associated with the seam and thrown into the gob, as worthless; or in the form of more or less large quantities of unsaleable coal or slack, which are in some cases thrown into the gob. Yet again, the material may be supplied in the form of a solid rib or pillar of coal, left either accidentally or pur-

losely, after re-opening operations, or on the side of a fault. ndeed, a colliery must be something extremely perfect that s clear of all these evils, if they may be so called.

(2) It has been assumed that a necessary quantity of oxygen i required for the combustion of the gob-material. Oxygen is eally and essentially one part of the combustible material, hough it is usual to consider the coal, shale and timber as ie material, and the oxygen as the supporter of its combustion. ll seams of coal are liable to combustion, slow or spontaneous, ccording to the quantity of oxygen that the mineral receives. furnace-fire is only a dead-burning agency, if the fire-bars are hoked, but if the fire-bars are kept open and free to induce raught, or admit oxygen, it burns much more brightly and apidly. No one ever heard of a fire raging in a completely olated portion of a mine; if one ever becomes conscious of a re, it is because one finds some smell or indication of its occurence. And if there be breaks or interstices in the gob, or solid trata, allowing the passage of the gob-stink from the seat of re into the roadway, it is quite as evident that there must be reaks or interstices in the gob, or solid strata, allowing the assage of air, and consequently oxygen, from the open roadray to the seat of the fire. It is very plain that there must be free connection between the fresh air and the fire, and it is lso clear that there must be a supply of oxygen necessary for ombustion.

(3) The writer has described how heat is derived from oxidaion, but that is not the only source. It has never yet been ossible to stow the gobs and to build the pack-walls absolutely ight: the best stowing and the most perfect packing possible an only delay the descent of the undermined strata, and observations made on the roadways in some mines show that the packs, originally from 5 to 6 feet thick from floor to roof, have been compressed and recompressed down to half, or even less han half of the original thickness. There must have been a arge amount of energy at work in the grinding and settling of the roof, and heat is produced mechanically by this friction. Besides this, we must reckon the additional temperature due to his friction acting on the gob-material, and also, the heat leveloped by the compression of confined gases in the pores and nterstices in the material or in close proximity to it.

e Causes of Gob-fires.—The three necessary conditions for
being unavoidably present in a mine, it will not be
ult to discover certain causes for gob-fires.

(1) Friction.—The grinding and settling of the roof tend
split up the gob-material and to expose fresh surfaces to th
ction of oxidation. Take, for example, a rib of coal le
after re-opening operations. In a cubic foot there is an expos
area of at least 4 square feet, assuming the cubic foot
coal to be "fast," but if this cubic foot be crushed or pulveriz
by the grinding of the roof, there may be an exposed area
perhaps, several thousand square feet. Coal absorbs oxyg
very quickly, and even more quickly as the coal becom
more broken up, and the exposed area becomes greater. A so
pillar of coal, left to support a main road, if it is not la
enough, is subjected to considerable pressure, the coal in it
pulverized by the weight, and the pressure, or the equivalent
fissured and such action produces heat, or the equivalent
a definite quantity of mechanical energy to a definite quantity
of heat. There is, however, a difficulty in ascertaining how
much of the increased temperature may be due to the actual
pressure, and how much may be due to the fissures started in
the pillar. Again, take the conditions arising when two work-
ings approach each other: the strata either break and fall
back on each side, or bend away on each side of the pillar
between the two workings, leaving open spaces on either hand.
The old workings may remain open for a considerable period,
then occur the conditions which are particularly favourable
to the origin of spontaneous combustion. It may be possible
that a little air is forced through the old workings and int
the open space, and this, together with the oxygen given
from the pillar of coal, may be just sufficient to generate
heat; while the amount of air may be insufficient to carr
the heat generated, or the mass of coal and other gob-ma
(broken coal, or packs or abandoned timber) may be su
to give off heat faster than it can be taken away.
grinding and the pressure on the gob-material continu
heat is produced, continuing the equivalence of
quantity of mechanical energy to a definite quantity
and the space becomes more and more confined; co

the heated gases become acted upon by an increasing pressure, until at last, they find vent into the newer workings.

(2) Oxidation of the Organic Constituents of the Coal.—It has been stated already that bodies exposed to air slowly combine with the oxygen, and this oxidation is accompanied by an increase of temperature, or as the coal absorbs oxygen, it heats, and this increase of temperature increases its capacity for taking up more oxygen, but the combustion is not complete, and carbon monoxide is formed. As the coal or gob-material absorbs more oxygen, more heat is produced, then the spaces becoming more confined, the resultant gases are compressed, while their natural tendency is to expand, and still more heat is produced, until, eventually, the temperature of ignition is attained. This temperature of ignition will depend upon the composition, and state of division of the coal, and the length of time during which it is exposed to air. Thus, before actual fire is detected, or really before combustion occurs, two actions are taking place, namely:—The heating of the gob-material, exposed to the oxidizing action of the atmosphere, and the immediately following and later stages of the distillation of inflammable gases; while the mechanical energy due to the pressure may also be an important contributory factor.

Moisture is another contributory factor, as its presence induces a tendency to heat in the gob-material. On this point, as on many others connected with this subject, a great difference of opinion exists. The writer will not say that moisture can, or does, cause combustion, but, whatever may be the cause, the effect of moisture is to assist the oxidation and heating of the gob-material, and so become a contributory factor. It may be briefly summarized that:—(*a*) Moisture facilitates combustion by splitting up the gob-material and offering a greater exposed surface to the action of oxidation. (*b*) In a region of high temperature, and in the unavoidable presence of heated carbon, the constituents of the water are disassociated and two highly explosive gases are produced, namely: carbon monoxide and hydrogen. (*c*) Water is a carrier of oxygen, and the effect of the evaporation of the water in the gob is to make the atmosphere therein richer in oxygen, and thus further facilitate spontaneous combustion. (*d*) Moisture increases the pressure,

sequently, the heat, in the confined spaces of the gob.
ases the pressure by swelling the solid material; and,
temperature rises, the little moisture in the gob will
ate, and then, as the space becomes more limited and the
rature gradually rises, it will increase the pressure more

(3) Oxidation of Iron-pyrites.—Iron-pyrites (disulphide o
n, FeS_2) decomposes in the presence of moisture and coal
atter, this decomposition producing heat and an expansio
the volume of the substance, and forming ferrous and ferr
ulphates. The heat is given off very slowly, and is probab
insufficient of itself to fire the coal, though it may aid in th
heating produced by oxidation and pressure. A great differen
of opinion seems to exist as to the presence of iron-pyrites ha
ing any effect in producing ignition, but it cannot be deni
that the decomposition of iron-pyrites may assist in initiati
a fire. It may not be out of place to state that iron-pyri
can originate a fire, since, when strongly heated with coal
process of oxidation it produces sulphuretted hydrogen, which,
being a gas with a low temperature of ignition, will materially
aid the oxidation and actual ignition of the coal or other gob-
material. At any rate, its effects in accentuating the danger of
gob-fires can hardly be overstated.

Summary of Causes.—"It is quite possible, in some cases,
that all these causes may combine to bring about combustion,
while, in others, any one of them alone may be sufficient for
this purpose."* But, it does not follow that, in any colliery
where the conditions necessary for fire are present, fire is certain.
The heat, for instance, may escape as fast as it is generated;
and so the writer is strongly of opinion that the character of
the strata in contact with the seam influences the liability
a coal to combustion. Under a sandstone-roof, since sandsto
is porous and a good conductor of heat, the heat may escape
fast as it is generated; while under a shale-roof, which ma
impervious to the gases formed, the heat may accumulate
so aid the combustion. On the other hand, the heat m

* "Underground Fires," by Mr. F. W. Hardwick, *Trans. Inst. M.*
vol. xxv., page 731.

generated, under favourable conditions, faster than the heated gases can escape, even with a sandstone-roof.

It would appear that the seams most liable to gob-fires are those which contain a high percentage of oxygen and volatile constituents, and that steam-coals, which are generally hard and of a close texture, may be considered free from the danger. Several instances are known, however, to the contrary, where fires have occurred in seams containing both hard and soft coal; nor can it be said that these fires have all been due to the more easily-combustible nature of the soft coal, or to the fact that they contain more oxygen and volatile constituents. The reason is probably found in the incidence of a solid pillar of such coal being buried in the gob. Suppose a pillar of coal of such a nature that the hard coal is overlain by soft coal, it is evident that any heated gases given off by the hard coal must be retained therein, since the soft coal is generally impervious, and so the action of oxidation would be obvious. Any heat generated by the soft coal may be allowed to escape. An example of this is shown in the experience of the writer, at a colliery working the Barnsley seam, in which the bag and day-bed coals are left to support the roof: a shaly bind. Timber and packs are set and built under the bag coal. Although the mine is very subject to gob-fires, no anxiety is felt because of the bag coal or day-bed coal being left, but should a rib of coal become accidentally buried, great anxiety is caused, and operations are at once commenced to find the rib and to get it out. In some cases, when such a rib has been found, oxidation has been active, heat has been generated, and, in all cases, the hard coal has become very hot, while the soft coal above it has not been found hotter than usual. This is one proof that the heat is retained in the hard coal.

The depth of a seam from the surface, the conditions of working, the composition and character of the coal, and the composition and character of the overlying strata may all be found to influence the liability of a seam to spontaneous combustion. The greater heat, at future increased depths, may induce a tendency to rapid absorption of oxygen, and consequently to combustion.

Once a fire has started, the presence of combustible material favours its spread; while the combustible gases, carburetted

n, carbon monoxide and sulphuretted hydrogen, help
it. The outbreak is often preceded by the emission of
nk, somewhat resembling paraffin, while there is also
able a rise of temperature and a sweating on the cooler
ces.

Prevention.—The prevention of gob-fires presents difficulties
peculiar in themselves as the causes. There are three
ecessary conditions for a fire: therefore, in endeavouring to
revent a fire, attempts must be directed to the removal of a
or any one of them. It is never easy to prevent the presence
of combustible material in the gob, but if this material can
be robbed of the heat and oxygen necessary for combustion
there will be no fire. This is the logical view, but it is not
practicable. Care and foresight may minimize the number
fires, but in some cases where such fires have occurred, the
strictest care has been exercised, and rules have been enforced
in order to prevent occurrence. The prevention is generally
attempted by some special system of working, or some alteration
in the ordinary systems of working, as the depth from the surface, and the composition and character of the coal and the
adjoining strata cannot be altered.

(1) The Removal of all Combustible Material.—Under a sand-
stone-roof, care and foresight, together with a good market, may
prevent ribs of coal or timber from being left in the gob, and
may prevent slack-coal from being thrown into the gob; but
even then a certain amount of waste and impurities is left. With
a coal or carbonaceous shale-roof combustible material is natur-
ally left in the gob. If slack-coal or impure bands in the coal
are found to oxidize and to cause gob-fires, it is better to spend
a little money in removing such from the mine than to incur
big expense in dealing with a fire.

(2) Free Access of Air.—The coursing of a strong c
of air through the place which is heating, in order to
and carry off the heat, has been suggested as a preventi
more than one occasion the writer has seen fire prev
tapping or opening out a place which had been fou
heating. Such a proceeding has the effect of libe

heat, which has been pent up, and reducing the temperature of the place. This can only be effected, however, when the heating is caught in a very incipient stage, otherwise the quantity of air admitted would breed a fire.

(3) Exclusion of Air:—It has already been stated that the best packs ever built cannot be made air-tight, hence, since the gobs are only separated from the roadways and faces by packs, it is evident that other means must be adopted in order that the air shall be excluded from the gob. This may be effectually done by lining the packs with clay-lumps or wax-walling. In some cases, sand or finely-ground ashes, are employed for the purpose of making the pack-walls hermetically air-tight. Anything can be utilized that has the effect of preventing infiltrations of air, but the material used must, of course, be non-inflammable.

(4) Working Home.—In working out all the coal away from the shaft-pillar, any danger left in the goaf will show itself in the workings, but if the roadways are driven out first to the boundary and the coal worked homeward or back to the shafts, the gob and its dangers are left behind. This system, however, has the decided disadvantage of not allowing any extension of area, and of heavy initial cost, coupled with a small output, when opening out.

(5) Working in Panels.—In the pillar-and-stall system, the area of coal can be divided into small panels separated one from the other by ribs of solid coal. The coal in such districts, or panels, can be worked out more quickly if the districts are small; and the number of openings being few, they can be quickly and completely isolated by stoppings of brickwork-and-sand. These panels are, however, generally difficult to ventilate.

It is usually costly and, in some cases, practically impossible to prevent the presence of any combustible material in the gob; it is just as difficult and costly to keep the material cooled down to a point below the temperature of ignition; and consequently, the chief preventive will be found in the exclusion of oxygen.

Probably the best precaution is to exclude the feed of oxygen to the gob, by making and keeping the gate-packs as hermetically

se as possible, and then, by rapid working, keep the faces
dvancing regularly, and follow up in the gate-roads, not more
han 60 or 100 feet from the face, with sufficient ripping to
bury the packs completely. In such a procedure, it is hardly
probable that air will permeate into or through the gob. Care
should be taken also to maintain a straight line of face, to avoid
ribs of coal or timber being left, and to remove thoroughly all
coal from the side of a fault, where a grinding action is almost
inevitable. Coal-cutting machinery has done a good deal
towards preventing fires by ensuring a straight, or regular, line
of face being kept, allowing efficient control over the roof.
pressure, and, in consequence, a more solid gob. Irregular
faces, broken down and out of line, do not allow the gob to
break and fill up as it should; and cavities are formed, the
pressure becomes more violent, and everything is conducive to
the initiation of spontaneous combustion. Whenever faces are
broken down, they have to be ribbed out, and some colliers are
so interested in their work as to care nothing if they can only
get the face "up" again: they require constant watching to
prevent the last portion of the rib from being buried and
abandoned.

In some mines, spontaneous combustion occurs so rapidly
that the gob-material heats to a high temperature, and, if the
feed of oxygen is not at once cut off, bursts into flame in a very
short time; hence frequent and periodical inspections of the
workings and roadways during and between shifts, and at week-
ends and on Sundays, should be made, and any increase
temperature or any unusual smell should be reported at o
to the management. Only trustworthy deputies and ot
should be employed, who know, and would notice, the first
of a fire, namely, gob-smell, steam and sweating.

The most stringent measures should be carried int
against any neglect in timbering and in packing in fac
fully leaving timber in the gobs, any attempt to draw
front row of timber before the back row, any attempt
coal and timber into packs, or the throwing of slack,
the goaf.

The writer has refrained from mentioning the sp
of working adopted in South Staffordshire for the
seam, a full description of which has been given i

uctions,* as that system of working can only be applied to that particular seam.

Extinction.—Although the means adopted for preventing gob-fires may lessen their extent and frequency, yet it is not always possible to prevent them. As the present coal-seams become worked out, it will be clearly inevitable to resort to seams lying at a greater depth, leading to enhanced difficulties of working, one of which will be increased liability to gob-fires; and recourse will have to be had to different methods of extinguishing these fires under the different and difficult conditions then encountered. Time is the most important factor, and precious moments wasted may mean failure: if the fire is given time to spread, its extinction will become more difficult, and may entail the closing of a section of the mine, or of the whole colliery.

(1) Stopping off the Fire.—The object of this method is to isolate the portion of the workings that is on fire, and to prevent the access of air to the fire. After deciding on a line, with the fewest number of openings crossing it, air-tight stoppings or barriers are built in each of these openings. If the air can be effectually kept from the fire in this way, it may soon extinguish itself, but it is not always possible to close all crevices. In some instances, fires have been sealed, and, upon the place being re-opened, the fire has been found to have been extinguished; whilst other fires have been sealed, and although the fierceness of the fire has been apparently killed at the time, as soon as the air has been re-admitted, the smouldering fire has again burst out in fury. Very divergent opinions exist as to how long it is necessary to seal off a gob-fire before it can be re-opened. Sometimes, it has been found necessary to close the shafts by putting scaffolding in them, and partly filling them with ashes, sand, etc., but this method is liable to give the idea that the fire is sealed off, when it is not sealed; and it is not a good method.

* "A General Description of the South Staffordshire Coal-field, South of the Bentley Fault; and the Methods of Working the Ten-yard or Thick Coal-seam," by Messrs. W. F. Clark and H. W. Hughes, *Trans. Inst. M.E.*, 1891, vol. iii., page 25.

(2) Drowning out the Fire.—This method is very effectual
ere it can be adopted, and may be accomplished by stopping
e pumps and allowing the water to rise, or by sending water
wn from the surface. This method is, however, very costly,
or the water has to be pumped out after the fire has ceased,
while the deteriorated condition of the strata and coal makes
its adoption a last resource. It is an undesirable method, where
the roof and floor is of a softish or of a clayey nature; and
the moistened coal is very liable to take fire again, owing to
moisture being a contributory factor.

(3) Carbonic Acid.—This gas can be produced in large quan-
tities by the action of hydrochloric acid on limestone, and then
conducted through pipes to the seat of the fire: the seat of the
fire being made practically air-tight by the means of stoppings.
This gas has the decided advantage over water of not injuring
the workings, and, mixing with fire-damp, reduces the danger
of explosion. Its use does not seem to be advantageous, how-
ever, for, while it has been used effectually in some cases, Mr.
W. H. Chambers* states that, in the case of a colliery near
Rotherham where the shafts were sealed and carbonic acid was
passed through the stoppings, it was found that the gas merely
suspended the combustion, which broke out as badly as before
when air was re-admitted.

(4) Filling out the Fire.—The most effectual method, and
in the end the cheapest as well as the safest, is that of driving
into the goaf and filling out the material that is on fire; and for
the complete extinction of gob-fires this is the only efficient
method, as the danger of the material again becoming ignited is
avoided by its being sent to the surface. The method of filling
out has been resorted to, and has been the means of complete
extinguishing many fires at the Denaby Main colliery. A f
description of this method of extinction has been given
Mr. W. H. Chambers.† The difficulties are often very cons
able, for, while air is especially necessary for the workme
account of the great heat and the poisonous gases evolve
such air helps to increase the combustion.

* "Notes on Gob-fires," by Mr. W. H. Chambers, *Trans. Inst. M*
vol. xviii., page 154.

† *Ibid.*

A hard-and-fast rule cannot be adopted for the extinction of gob-fires, as each district must be worked under its own peculiar conditions, and each gob-fire must be dealt with on its own merits. In North Staffordshire, for instance, owing to the acute angles of dip of the coal-seams, gob-fires often occur in accessible places, in drifts and steep workings, and require more careful handling than in other districts. Again, in North Staffordshire, many gob-fires have been attended by explosions of gas, many of them certainly small, but some causing loss of life.

The writer is of opinion that many gob-fires could be filled out, if promptly caught in the incipient stage. The danger would then be removed out of the mine, but it is always present if the fire is sealed off, as the chemical action of combustion will then lie dormant so long as the place is sealed off and no air is allowed to pass to the seat of the fire. As soon, however, as the place is re-opened, the danger returns, chemical action is restarted, and there is imminent danger of the fire again breaking out. In a seam or mine subject to gob-fires, the goafs should be sealed as a preventive, and not left to be sealed as a cure. Since many fires have broken out anew after having been sealed off perhaps for many years, and some of them have been attended with disastrous loss of life, the writer is not asserting too much when he says that mining engineers should exhaust every possible means and efforts to extinguish utterly a fire by removing it, before resorting to an attempt to prevent its encroachment by wax-wallings and stoppings, and leaving it to die out gradually, or to smoulder on and break out again.

Summary and Conclusion.—The writer has endeavoured to show that the laws of the atomic theory and the laws of combining proportions are very closely associated with the reactions of the gob and gob-material; that a definite quantity of mechanical energy is equivalent to a definite quantity of heat; and that oxygen is present in the goaf, and carried in, from such sources as the chemical constituents of the material, the air, moisture, etc. There are thus three conditions necessary for spontaneous combustion, a combination which would result in a fire.

Coal absorbs oxygen quickly, and more quickly as the surface open to oxidation increases, and as the heat increases; so that, any cause which will split up the gob-material will aid in

initiating a fire. Moisture assists the oxidation and heating by splitting up the gob-material, wherefore this also may be considered an important factor.

The depth from the surface, with the peculiar conditions attached to each colliery separately from others, may influence the liability of the seam to spontaneous combustion; hence, as the workings become deeper, and the normal temperature of the mine is increased, there will be greater risk of the occurrence of these fires.

In every case in which a fire has been properly located, prop[illegible] left in the goaf, or ribs of coal left against faults, or falls in [illegible] working stalls burying a rib of coal, have been found to be the [illegible] origin. Hence, a good deal in the way of preventing these fire[illegible]s depends to some extent on the management of the collieries; an[illegible]d on oxygen not being allowed to percolate into the goafs in suc[illegible]h quantities as to breed fire.

In any method of extinction, means must be taken f[illegible]or cooling the hot material, by the application of substances whi[illegible]h will absorb the heat and reduce its temperature to such a degr[illegible]ee that combustion entirely ceases in a natural atmosphere; or [illegible]by the removal of the combustible material from the influence [illegible]of the heat.

Mr. W. N. Atkinson (H.M. Inspector of Mines, Barlast[illegible]on) said that there were great differences of opinion as to the pro[illegible]per way of dealing with a gob-fire. Many people advocated digg[illegible]ing out the fire as a *sine qua non*, and as the only proper meth[illegible]od; others were very well aware that to adopt that course would [illegible]be highly dangerous in some cases; yet others professed that [illegible]the only proper way was to build the places up, stop the access [illegible]of air, and so cause the fire to be extinguished. His own view [illegible]of the matter was that the extinction of the fire was entirely governed by the circumstances and conditions of each individual case, and that no general rule could be laid down for their guidance, as what would be the best course to pursue in one case might be the worst course in another.

[illegible]Mr. S. F. Walker (Bath) said that the law of the conserva[illegible]of energy decreed that they could not obtain energy for [illegible]ng, and they could not have heat for nothing. The heat in

e coal was produced either by chemical action or by friction. e considered that heating was chiefly due to oxygen combining ith the carbon in the coal. When carbonic oxide was formed by ie union of carbon with oxygen, the chemical action liberated a rtain amount of energy, and chemical action in the case of yrites also liberated energy. He suggested that a careful eries of measurements should be made of the conductivity and pecific heat of coal and other minerals, because the storage of eat depended upon the specific heat of the coal, and of the sur-ounding, overlying and underlying strata, and upon their con-ictivity. If the overlying strata had a high conductivity and ere was a large mass of them, probably the heat would be dissi-ted harmlessly. On the other hand, if the overlying strata re good thermal insulators, then the heat would be stored and u ble would be experienced. Further, the temperature assumed the coal would depend upon the heat delivered to it and upon specific heat. If the specific heat of the coal was low the more idly would its temperature rise.

The most important question was the removal of the heat. rude method would be to drive very carefully the air-current ng the coal; this method would be expensive, because air, ing a low specific heat, would not carry off a large quantity eat, and there was always the danger that it might be adding gen, and so increasing the trouble. Compressed air might be harged over the surface of the coal where the heat had com-ced; the air, in expanding, would absorb part, or all, of the t, but this might be an expensive and troublesome method. vapour of water might be discharged upon the heated face, and if allowed to condense on that surface and then rmed into vapour, each pound of water converted into vapour uld absorb about 900 British thermal units, much more than uld be absorbed by any other process. He was of course tching out only a crude suggestion, but he thought that in e case of the air sent into a mine or a place troubled with gob-e or heat being at a comparatively high temperature, a simple frigerating plant might be used to cool down the air, thus educing its capacity for absorbing moisture, and so allowing f the deposit of condensed moisture upon the surface that they wished to cool. The revaporization would remove 900 heat-units with each pound of water, and it appeared to him that the heat might well be removed in this manner.

Mr. Arthur Sopwith (Cannock Chase) thought that exper[illegible]. e of a number of gob-fires and a good practical knowledge [illegible]f e methods of dealing with the conditions were better than ac[illegible]t. g on theoretical views. The main point to be remember[illegible]d as that coal might become gradually heated, by absorbing a ertain amount of oxygen from the air, while not receivi[illegible]g a sufficient amount of cooling air to remove the heat produc[illegible]d by such oxidation. The brown coal of Bohemia, containi[illegible]g a large proportion of hygroscopic water, in drying, beca[illegible]me reticulated with cracks for some distance into the solid, and the air circulating in the galleries could not freely reach the extremities of such cracks, although the coal received sufficient oxygen and increments of heat were added, which ultimately led to the firing point being attained. It was most important, in mines where gob-fires were likely to occur, that the management should detect every gob-fire before it attained any considerable size. If a gob-fire had attained the incandescent stage, the air should be kept from it until the incandescent coal had been filled away and then as much cool air as possible should be passed over.

Mr. H. Richardson Hewitt (H.M. Inspector of Mines, Derby) said that he did not agree with Mr. Farmer that, in every case, props left in the goaf, or ribs of coal left against faults, or falls in working stalls burying a rib of coal, had been found to be the origin of gob-fires; and there were several recorded cases where it had been proved that a gob-fire had started in a place in which no coal or timber had been left. Mr. Farmer did not give suff cient weight to the fact that ventilation would lower the temper ture of the mine generally. Of course, the ventilation wo require to be reduced if the fire became extensive. Mr. Farr also, had said nothing about the application of water, whicl some people's estimation, was used with doubtful advantage. Farmer said that the filling-up of the material was the method of dealing with a small fire, but he had not suggest material with which the holes should be filled, and, of cou (Mr. Farmer) knew that sand and burnt-out material fr surface often replaced the material that had been remov could not too strongly advocate the use of a thermor ascertaining the temperature, in preference to a ma which was a most uncertain indicator of temperature.

Mr. J. C. FORREST (Wolverhampton) said that, wherever practicable, the fire was loaded out and the space filled with flue-dust. He noted that water had been used effectually by others, but in his own experience in three places where water had been used, it ran down hill to another part of the colliery (whether simply a coincidence or not he did not know), and started a fire there, not immediately, but shortly afterwards. He asked whether any of the members had experienced this difficulty.

Prof. R. A. S. REDMAYNE (University, Birmingham) thought that the question was not entirely a chemical one, and that the physical properties of the coal played a very important part in determining its liability to spontaneous combustion. The more friable the coal the greater, he thought, would be the absorbtion of oxygen from the air. Hence, underground fires were very rare in the North of England and common, comparatively speaking, in the Midlands. Liability to spontaneous ignition was not due necessarily to the depth of the seam from the surface. The Thick coal-seam of South Staffordshire, within a few feet of the surface, had frequently been subject to fires, and it was noticeable that where the coal was friable fires were more frequent than where it was less friable.

Mr. W. F. CLARK (Walsall) said that he had had fires in the Thick coal-seam, and he had kept open for many years a road which had fire all round it. The roadway was arched for a length of 1,000 feet with firebricks, and these became so hot that for 3 years they could scarcely bear to place their hands upon them. The fire was kept in abeyance solely by water; no difficulty was experienced from the hot water running into other parts of the mine; it was not allowed to pass on to any old gob; and it had never assisted in the creation of fires elsewhere. He was inclined to think that in the cases mentioned by Mr. Forrest the fires were only coincidences.

Mr. M. W. WATERHOUSE (Bedworth) said that he had had a similar case, in which the solid coal on each side of the roads was on fire, and heated the arches as described by Mr. Clark. The fires were reduced by inserting pipes and running in water. The water came out at a high temperature, below the burning mass, but it had not produced any damage greater than that which water generally caused.

Mr. J. S. Hollings (Brymbo) said that in the Thick coal seam it was desirable to apply the water to the fire as soon as was discovered; but in longwall working, where gob-fires properly so-called, occurred, he had noticed that, when water was applied, the fire continued to spread, unless the hot stuff surrounding the fire was speedily removed. After the fire had been filled away, it was possible to remove the heat by water, so that the fire would not spread; but if it was not possible, the heat would drive the fire further into the gob.

Mr. George E. Lawton (Harecastle) said that he was pleased to note that Mr. Farmer agreed with many of the theories and conclusions set forth in his (Mr. Lawton's) paper on "Fires in Mines" recently read before the North Staffordshire Institute of Mining Engineers.* He scarcely thought that "free access of air" into a place which was heating was perhaps the best course to take for the prevention of fires. Obviously, this method would introduce more oxygen into the region of the affected area; it would tend to promote more rapid oxidation, and would probably defeat the object in view. It was undoubtedly a difficult matter to make packs air-tight, but if the goaves were allowed to become charged with fire-damp, the atmosphere in the goaves would be such as to prevent fire; this method had been successfully accomplished in some cases. Wax-walling did not appear to be a very suitable method of excluding the air, and when subject to roof-pressure it would be liable to crack and admit the air readily. The system of working in panels was the best system to adopt for dealing successfully with gob-fires when they occurred. He (Mr. Lawton) had adopted this system of working seams subject to gob-fires with success, but he had not experienced any difficulty in ventilating the panels as suggested by Mr. Farmer. He did not agree with Mr. Farmer that the most effectual method of dealing with fires was to fill up the incandescent materials. However, under favourable conditions, it might be the best method to pursue; but, in a gassy mine, it would, in most cases, be a highly dangerous and costly operation and disastrous explosions might result. Mr. Farmer was in error when he said, "Again, in North Staffordshire, many gob-fires have been attended by explosions of gas."† Some explosions of gas had occurred as

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 109.

† *Ibid.*, 1904, vol. xxviii., page 449.

e result of gob-fires, but these had been exceedingly few in comrison with the number of fires that had been dealt with. The cognized method of working seams subject to gob-fires in the rth Staffordshire district was by the panel-system, so as to clude air from the goaves and to allow them to become charged th fire-damp, and if this state of affairs could be accomplished was impossible for combustion to continue in the goaf.

Mr. F. C. SWALLOW (Hednesford) wrote that Mr. Farmer uld have been assisted in arriving at practical and valuable nclusions as to the cause and prevention of gob-fires if he had o submitted statements shewing the chemical analysis, nature the roof and floor, depth or thickness of superincumbent ata, system of working (with special reference to waste in rking and slack or small coal left in the goaf) of seams which had worked where gob-fires were prevalent or liable.

He (Mr. Swallow) had had considerable experience in working ams of coal in which gob-fires were very liable to occur, and ere every precaution was necessary to avoid the same; and was of opinion that the thick bituminous seams of the Staffdshire and Warwickshire districts were especially liable to b-fires, owing to the comparatively large percentage of moisre and volatile matter in their composition—ranging from 12 15 per cent. of the former and from 35 to 38 per cent. of the ter constituent. He had worked for some years seams which re specially liable to spontaneous combustion, where no trace carburetted hydrogen or fire-damp had ever been found.

The nature of the roof of seams liable to gob-fires was an portant factor, as if this was bad (necessitating the leaving of coal over the pack-walls and getting the top coal only in the astes), there resulted an unavoidably large percentage of loss in rking, and the consequent crushing of this coal in the goaves ndered it liable to the reactions described by Mr. Farmer. Gobes were consequently more likely to occur in thick seams of al at depths of say 750 to 1,000 feet, having a bad roof, and robably) a damp fire-clay floor, where the enormous movement d breakage of the superincumbent strata as indicated by the rinkage or subsidence of the surface which was found in such stances, must inevitably generate heat sufficient to ignite the ished bituminous coal; and if air penetrated into the wastes or aves it aided the chemical action.

(Mr. Swallow) had worked the Thick coal-seam of War-
hire at one of the collieries under his management, where
precaution was necessary in order to avoid spontaneous
ustion in the wastes or goaves. In this instance, where the
of the measures was about 1 in 5, it was found that when the
section of the coal-seam (about 22 feet) was worked to the
on the Warwickshire jig principle, there being three lines of
l-face each about 30 feet behind the other, it was impera-
e that particular attention should be paid to the pack-walls on
e main road and gate-roads. Ashes, brought from the burnt-
ut clod-tip on the surface, were used to close the sides of these
oads as tightly as possible, so as to prevent air from circulating
through the wastes. This precaution proved successful, but the
writer found that the labour-cost entailed became excessive when
the jigs extended beyond 450 feet in length, and he thought that
this distance was about as far as the system could be worked
profitably.

In the same seam, he also worked a large area of coal on the retreating longwall principle without expense from gob-fires. Two headings (an intake airway and a return airway) were driven to the full dip for a distance of about 2,500 feet into the area of coal to be worked, and at this point three lines of coal-face were opened out and the coal-face worked in the same manner as in the jig or rise district above referred to. The mine-water, about 3,000 gallons an hour, was allowed to run into and fill up the old wastes to the dip of the working-faces. The level or tail-end of the water, lying within 20 feet of the last line of coal-face, was kept in check by means of a pump driven by compressed air. The air was thus absolutely prevented from getting into the wastes. He had heard of a case where drowned wastes had been drained after some years, for the purpose of driving a pair of gob-roads through them to an area of unworked coal beyond. The roads were very securely arched with brickwork, but, after a while, because of air penetrating into the damp wastes, spontaneous combustion ensued, and the arching became so heated that the roads were abandoned.

Boiler-flue dust was an excellent material for gobbing up the rough sides of pack-walls, and was usually kept for that purpose.

Mr. I. Meachem, jun. (Birmingham), said that in the working of thin mines where gob-fires occurred, the actual seat of the fire

was hidden, and the exact cause, and often the process, of spontaneous combustion was not seen. But, although materials were generally at hand to assist in arriving at a conclusion as to the cause of the combustion, yet in the working of the Thick coal-seam of South Staffordshire, the seat of the fire was often accessible, so a few facts as to the occurrence of fires in that seam might be of use.

The South Staffordshire Thick coal-seam varies from 24 to 30 feet in thickness, so that it can only be worked by driving out roads to the boundary and working the coal homeward. In his experience of working in the Thick coal-seam the places where fires mainly break out are:—(1) The ribs at the back of the stalls. By referring to the paper by Messrs. W. F. Clark and H. W. Hughes,* it will be seen that the Thick coal-seam is worked in large stalls; and after the back rib is cut off in the stall, the coal is worked homeward. The air is kept near the face of work, consequently the air at the rib becomes stagnant, and the back rib is often the seat of a fire. (2) The large pillars left in the stalls for support; the same conditions prevail here as at the rib. (3) The roads, most especially in mines of considerable depth, such as the Hamstead colliery. (4) The fine slack left in the stalls. (5) The slack-heaps on the surface. (6) The "slip-things" or, as they are sometimes termed, geological fissures, which are often crevices filled with fine coal-dust. (7) The broken coal lying over the road-timbers. (8) The parts of the thick coal-seam which are most subject to fire, are soft friable measures, with numerous small faces.

Fire rarely, if ever, occurs in the small pillars surrounded by cool air; or in slack-heaps on the surface when ventilated. It is evident therefore, that when fissures are formed in the solid coal by pressure from the roof, there spontaneous combustion takes place, such as in the back ribs of stalls and in large pillars. In roads chiefly, if not entirely, the fissures occur within 2,000 to 3,000 feet from the downcast shaft. This happens mainly in deep mines, where the pressure of the strata causes fissures to form on the sides of the road. In such cases, the fire is rarely discovered, until it either shews itself by smoke or actual flame.

IV.

* *Trans. Inst. M.E.*, 1891, vol. iii., Fig. 12, Plate III., and Fig. 18, Plate IV., page 48.

The slack-heaps left in stalls should not be of any great size, as a few tons lying in a stall will often fire.

On the surface, spontaneous combustion takes place in the slack-heaps, which are generally of considerable size. Small heaps rarely fire. He (Mr. Meachem) had occasion to put into stock, some years ago, a large quantity of slack. Circumstances compelled him to put it all in one heap, but he adopted a system of ventilating the heap by means of rough wooden tubes, by which means the heap was kept quite cool and no fire occurred.

He (Mr. Meachem) had occasion many years ago to make a mound, 10 feet high, of fine slack, and on this a severe snow-storm deposited a layer of snow, 2½ feet thick; on this another layer of slack, 10 feet thick, was deposited; and some 18 months later, when the slack was removed, the layer of snow was still there, and no signs of heating could be detected.

From the above facts it may be inferred that coal absorbs oxygen from the air, and the greater the number of faces of exposed coal the greater the oxidation. Unless sufficient air is passed along to reduce the temperature of the coal, oxidation is set up, heat is generated, and fire ensues, as evidenced by the foregoing cases of heating of ribs, large pillars, and sides of roads. The firing of fine slack-heaps and of broken coal over the roads testifies to the fires being produced from the same cause. The absorption of oxygen by coal has been abundantly proved by exhaustive tests at the Hamstead colliery, where the return-air was found to be deficient in oxygen, and men and horses were suffering in consequence.

The pyrites occurring in the Thick coal-seam is so small that its influence can hardly be recognized as contributing to spontaneous combustion in that seam. This, however, must not be considered as an argument against its influence in other seams, but as simply shewing that although pyrites may be present in such small quantity as not to exercise any appreciable influence, yet this may be more than counterbalanced by the greater area of coal-faces exposed to the oxidizing influence of the air.

In the Thick coal-seam it is found that an increased volume of air passed through the workings does not cure, or even to any appreciable extent alleviate, the trouble. It has been tried, and in one case an increase of over 50 per cent. in the volume of air passed through the mine did not cool the workings to any per-

ptible degree: the gate-road fires still broke out, though they emed to be nearer to the face than before, yet the general conditions prevailing in the mine appeared to be unchanged.

The obvious lesson to be learned is that constant watchfulness ust be maintained, stalls must be made of moderate dimensions, re must be taken that slack is not left in the stalls, and ures in roads should be frequently and carefully examined, l, where possible, with a thermometer. As to the extinction a fire, no sure and certain method can be adopted suitable all cases; when a fire occurs in stalls, it must be dammed off, if over a road it must, if possible, be removed and loaded up. He (Mr. Meachem) had had a case where a fire occurred on a l. It was shut off by a dam, as it had attained such proions that it was impossible to load out the burning material; the air necessary for the respiration of the workmen fed ire to such an extent that it became unmanageable. Under circumstances, the fire being within 300 feet of the downcast , it was decided to try and check its progress by the use of nic acid gas. Two large tanks were taken into the mine, filled with small pieces of limestone; dilute hydrochloric acid poured in, and the carbonic acid gas, thus produced, was cond in pipes to the seat of the fire. The fire was kept in k by this means, until a strong brick-arch was built from ottom of the shaft and continued under the road in which ire was burning, until the fire was effectually sealed off.

Mr. J. A. Longden (Stanton-by-Dale) wrote that Mr. Farmer's esting paper on gob-fires caused him to describe, for the fit of others, some experiences that he had had with fires in pit. None of the three cases, however, had been what was n technically as a gob-fire.

A compressed-air driven hauling engine, a mile away from pit-bottom, being short of pressure, an Ingersoll heater was ed, and 10 per cent. more power was produced from the air. s heater was supplied with gas-coke, and one day, in the nce of coke, coal was used, and the sparks ignited a pillar oal which had been left to support a water-level. Until the ke was perceived in the return airway, no one had any wledge of the fire, and by that time it had attained siderable dimensions. An attempt was made to extinguish

it with a stream of water which ran in the water-level, but this failed, and several months were spent in surrounding the fire with fresh headings, and in wax-walling the side with clay and sand. After an expenditure of about £2,000, this fire was finally extinguished.

In the second instance, two boys were eating their food at midnight in an engine-house near the pit-bottom, which had a wooden floor on pitchpine balks, and all of a sudden the main level was in a blaze; the boys have never admitted it, but they must have caused the accident through upsetting paraffin or a naked light. The flame rushed down to the levels, completely gutted the engine-house, and cracked the cylinder of the engine. The floor had been in use about 20 years, and the timber was dry and rotten. The ventilating current pulled the flames in all directions and set the shaft-pillar of coal on fire, and it was many weeks before the various courses which the flames had taken could be followed; moreover, as the shaft-pillar had been in existence for about 40 years, the very fine dust lying close to it easily caught fire.

Water was taken from the rising main of the pump to play on the fire, and it was followed up vigorously. The temperature in some places reached 100° Fahr.; it was almost impossible for the men to work in that heat, and the roof became so hot that it took months for it to cool down. There can be no doubt that wooden floors in engine-houses are very dangerous, both on the surface and underground, as the heat given off by the steam causes the wood to become very combustible.

The third fire was no doubt due to the stallman leaving a naked light in the stall; and instead of examining the place before he left and leaving everything safe, he absolutely caused the fire in question. As several hours elapsed between the time when the stallman left the pit and the deputy went round, the fire got considerable hold and caused great loss both in output and in wages in extinguishing it. The place was a mile away from the pit-bottom, and, as there was no water, extincteurs were very helpful in putting out the fire.

These three cases illustrated three principles of extinguishing fires. In the first, wax-walling was the only remedy available: in the second, a good supply of water at a high pressure was used; and in the third, filling out the fire with shovels and using extincteurs was the only means of dealing with it.

There was little doubt that there would be far more fires in the future than there had been heretofore, as fine coal-dust was gradually worked up into such a condition that it was easily ignited: this was partly due to age, and would hereafter be increasingly due to depth. There were few occurrences more unpleasant in a mine than a fire, whether it was spontaneously ignited or not.

Mr. F. G. MEACHEM (Dudley, Worcestershire) wrote that whatever might be the ultimate conclusion as to the cause, it was the fact that certain seams were liable to spontaneous combustion and others were not so liable until they reached a depth exceeding 1,000 or 1,500 feet. This showed plainly that mechanical force played the most important part in firing blocks of coal cut off for any purpose and left in the waste. The grinding force was concentrated upon these pillars and reduced the coal to a fine powder, considerable heat was generated, and absorption of oxygen then became easy. This fact should be borne in mind by every under-manager when cutting off such blocks of coal, and if that was possible it would pay to drive to them or leave open a road so that they could be either removed or properly isolated. The gob did not become solid in a time short enough to prevent the access of air to a ground-up pillar or accumulation of fine slack. He (Mr. Meachem) had known several cases where a roadway had been driven 300 feet in advance of any air-crossing, and the fine slack had fired in the breaks of the coal and formed its own air-current, the smoke passing outward along the top of the road and fresh air feeding inward to the fire along the bottom. Moisture, if it could be made to pass over the seat of the trouble and to convey away the heat, might prevent a fire, but he (Mr. Meachem) had always found that it was one of the first products of a fire and the surest warning that one could have of the existence of a fire.

When dealing with a large body of fire by means of water, if there was much actual coke and bright fire, then great care must be exercised in pouring water on to it, as in several cases water-gas had been produced and slight explosions had taken place, which, if the gas had accumulated in confined places, would have been very serious.

There could be no doubt that the best means of preventing

fires, was the removal of the pillars as soon as the purpose f[or] which they were left had been accomplished. Attention shou[ld] also be directed to the mode of working, especially in cases wh[ere] the seam was over 1,000 to 1,500 feet deep; and he (Mr. Meache[m] was of opinion that a modified longwall or panel-system would [be] found to be safest, say, to remove an area of coal, measuring 3[00] feet by 600 feet or any other suitable size; and leave a rib, s[ay], 25 to 30 feet wide round the excavated area, but such ribs m[ust] not be made too narrow or they would become a cause of fi[re]. This method was really the South Staffordshire system of squar[e]-work, but worked by longwall in the areas instead of by leavi[ng] pillars. Then, as soon as an area was finished, sand-dams could [be] inserted, and the area closed. Mr. E. B. Wain had, the writ[er] believed, adopted this system at Chatterley-Whitfield collieries [in] North Staffordshire, with great success. It should be alwa[ys] borne in mind when building stoppings round a fire that the dam[s] should go up together in height as near as possible. The a[ir] would be then going in and coming out of the enclosed area at th[e] top of the dams, leaving the heavier gases on the floor, thus help-ing to retard the fire. Then, as soon as the return-dam was built within 1 foot of the roof, an arrangement should be made so that both might be closed at the same time; but, in any case, the return-dam must be closed first.

He (Mr. Meachem) had seen carbonic acid gas used several times, but never with success. Air consisted of 79 parts of nitrogen, an absolutely inactive gas, and he suggested that some means should be devised for absorbing the oxygen and using the nitrogen to extinguish the fire. This gas had been his best friend during 25 years of battling with fires. If a fire could be sealed, then the fire and the coal absorbed the oxygen, and left an atmosphere of nitrogen, by which the fire had always been conquered.

The Chairman (Mr. J. C. Cadman), in moving a vote of thanks to Mr. Farmer for his paper, said that there was no royal road in dealing with gob-fires, and each must be dealt with on its merits. He had had considerable experience with such fires; some he had been able to dig out, some to water, and many of them had been built off. There was only one method of working the rearer mines, which were subject to gob-fires in the North Staffordshire

district, and that was by working the mines in panels; and immediately the slightest gob-smell was found, it must be tackled; for if it was not taken in hand at once, it would fire before it could be built off, and most probably a disastrous explosion would occur. The panel system generally adopted in working the Bullhurst seam in North Staffordshire was to open out the work with two roads; intake and return stoppings were prepared, and door-frames were built, so that immediately any smell appeared the doors could be closed and the stoppings strengthened afterwards. By that means, such explosions as those to which Mr. Farmer had alluded were, so far as gob-fires were concerned, practically things of the past, although gob-fires had previously been the cause of serious loss of life in that district. Water, applied to put out a fire in one part of a mine, might pass on to other parts and cause a further fire; and this had occurred in several cases in the Bullhurst seam, where the water had passed on to an old gob.

Mr. W. F. Clark, seconded the resolution, which was carried with acclamation.

Mr. G. Farmer, in acknowledging the vote of thanks, said that he had tried to point out in his paper that there was no royal road, or cast-iron rule defining the method of extinguishing a gob-fire. He thought that each one must be dealt with on its own merits; and as every mine was differently arranged, or was different in its conditions from another, so the conditions with regard to fires were different. One speaker stated that he had known a fire where no timber or coal had been left in the goaf, but it was evident that some combustible material must have been present. The overlying and underlying strata furnished a thermo-insulator and the heat was boxed up; and if accurate measurements were taken it might be easy to foretell where fires were likely to appear in mines. When this was ascertained, it might not be too difficult to prevent the fire from becoming incandescent; either by extracting the heat from the place, or by preventing the access of oxygen. The heat might be extracted by discharging water-vapour on to the surface of the place, and the oxygen might be excluded by forcing thin milk of lime into the crevices, breaks and interstices of the strata, and into the interstitial spaces of the goaf-packing and roof-fissures. Milk of lime had been used for many years in Northern Bohemia for combating gob-fires, although

generally regarded as a last resource, but it might be used for the more perfect exclusion of air or oxygen from any place where a fire might be thought likely to occur. When the limit of oxidation had been passed, and the coal became incandescent, air must be kept away from it. Water might be used, but as sparingly as possible. He strongly deprecated water being copiously poured on to an incandescent mass, because the steam evolved had a destructive effect on the roof, in many cases bringing down big masses and liberating more or less large volumes of gas. In removing material which was incandescent, he suggested that the stuff might be drawn out and then cooled down gradually by a thin stream of water. Of course, the incandescent material must not be allowed to burst into a flame. When the combustible material had been removed, the spaces thus made should be refilled with some incombustible material, such as sand. He did not know of any case where water, which had been used at a fire, had definitely caused another fire, but he thought it quite probable that heated water might be a contributory factor, as its presence would induce a tendency to heat in the gob-material.

Prof. R. A. S. REDMAYNE read the following paper on "The Mining Department of the University of Birmingham":—

HE MINING DEPARTMENT OF THE UNIVERSITY OF BIRMINGHAM.

By R. A. S. REDMAYNE.

It has been suggested to the writer, in view of the visit he Institution of Mining Engineers to the city and district irmingham, and their proposed inspection, amongst other ts of interest, of the new Applied Science Buildings of the ersity of Birmingham, now nearing completion, that some ription of the course of training pursued in the Mining rtment, which has been in operation for two years, might e of interest to members of the Institution; the more so aps, as the subject of mining education has recently come to the fore, and occupies a prominent place in the discus- of mining societies, and in the pages of the technical . It is proposed, therefore, to give some account of (1) scheme of mining instruction, and (2) the nature of the ng equipment at the Midland University.

cheme of Instruction.—Mining is a very extensive and sified subject: indeed, in its entirety, it may well be spoken an agglomeration of subjects, wherefore the courses of mining uction and study to be pursued at the University have been so aged as to meet the requirements of those engaged in all, y, of its different branches, namely of those who intend to ne (1) practising and consultative mining engineers: where rough knowledge of mining in all its branches is necessary. olliery managers: where, in addition to an acquaintance general mining engineering, a special knowledge of routine ery management is essential. (3) Managers of metalliferous s: in which case it is necessary to specialize in the methods of ng different ore-bodies, and the various ways of dressing ent ores. (4) Teachers of mining: such as county-council rers, and lecturers in technical colleges. (5) Mine sur- s: where, besides a general knowledge of the theory and ice of mining, a thorough understanding of and proficiency

in practical colliery-surveying, metal-mine, and land-surveyi and planning is absolutely necessary. (6) Land and estate agen who should not only be able to undertake a surface survey, a be capable of understanding the details of an underground t verse, but should have a knowledge of stone and slate quarryi if not, indeed, of the general principles of mining also. A finally may be included (7) land-owners and owners of collieri and those generally interested in mines and quarries.

In the work undertaken by the University, it will be observ that the field covered by county-council mining lecturers is nowise trespassed upon, and it may be stated that no evenin classes are held. Admirable work is being accomplishe in the Midlands by the able lecturers in mining appointed b the county councils; the classes are large, and the student in the majority of cases, enthusiastic. Some of the more ac vanced of the latter naturally proceed to the University, an constitute a very desirable class of students.

The full three years' curriculum has been constructed o the principle of giving a thorough grounding in pure scienc during the first two years (with instruction in the theory an practice of mining), and devoting the third and last year entirel to the application of the scientific knowledge so acquired t engineering: mining, mechanical, civil, electrical and meta lurgical: all specializing and research-work being relegated to post-graduate or fourth year.

Mining Course.—The complete or degree mining cour includes:—

First Year.—(*a*) Mathematics, under which are comprehend algebra, trigonometry and geometry. . (*b*) Physics, lecture an laboratory, including mechanics, sound, light, heat, magnetis and electricity. (*c*) Geology, physical, historical and local, wi field-work. (*d*) Mining and mining engineering, lecture, cl and outdoor work (course 1).

Second Year.—(*a*) Chemistry, lecture and laboratory, co prizing the general principles of chemical science, the systema study of the properties of the more important elements and th compounds, and an indication of some of the chief applicati of chemistry in the arts and manufactures, with chemi analysis. Periodical visits are made to some of the gre

factories in or near Birmingham, in which chemical and metallurgical industries are carried on: these excursions being conducted by the professor. (*b*) Geology, petrological, structural, stratigraphical and areal (field-work), economic geology of Great Britain, mineralogy and petrography. (*c*) Engineering drawing, machine drawing. (*d*) Mining, lecture, laboratory and outdoor work (course 2).

Third Year.—(*a*) Engineering, lecture and laboratory practice. A course in descriptive engineering: boilers, steam-engines, gas-engines, oil-engines, tools for wood and iron, applied mechanics and graphics, electrical engineering. (*b*) Metallurgy and metallurgical laboratory. (*c*) Mining, lecture and laboratory (course 3).

The detailed courses in mining are as follows:—The first year's work is devoted to such subjects as prospecting and boring, sinking, underground development and systems of working, surface and underground transport of minerals, winding, drainage, ventilation, sorting and screening of minerals, and surveying and planning. During the second year, the details of colliery and mine management and mining jurisprudence are considered, in addition to which there is an advanced course in surveying and planning. And to the third year is consigned the study of coal and metal mining conditions abroad and the dressing and preparation of fuels and ores for the market.

It will have been observed that there is no mining laboratory practice during the first year, but a considerable length of time is given to laboratory work in the second and third years. Allusion is made to the nature of the laboratory work, later on, when dealing with the apparatus and general equipment of the department.

There are three classes of mining students attending the University, namely, what may be termed (1) irregular or occasional students, who may take the first year's work (which, in itself, constitutes a complete elementary mining course), or who may elect to follow any of the courses already described. (2) Those who desire to obtain the diploma in mining, in accordance with the terms of the Coal-mines Regulation Act (1887) Amendment Act, of June 30th, 1903, and who have to take the first and second year's mining, together with the lecture and laboratory courses in

the allied sciences included in these two years; they must, further, have practical experience in a mine (coal or metal) for a couple of months, at least, in each year, or have had a minimum of four months of such experience prior to entering upon the diploma course; and (3) there are the degree students, those who intend proceeding to the degree of bachelor of science in mining, and who are required to be matriculated in the faculty of science before entering upon the course of study for the degree, after which they must pass in all the subjects contained in the complete three years' curriculum. They must also attend at least two of the summer schools in practical mining, or a minimum of 75 per cent. of the occasional visits to mines made during the session.

Summer School of Practical Mining.—This school takes place in every long vacation, the object being to devote several weeks in each year entirely to the detailed study of the plant and methods of working of a particular class of important mines, so that students may see for themselves in actual practice, much that they have had described to them in the lecture-theatre and class-rooms. Questions are asked, problems discussed, notes taken, and sketches made; and the students are brought in close contact with the captains of mining industry, whose ranks they hope some day to join—in itself a wholesome experience. On the termination of the summer school, the students prepare a report on all the work done, which they submit to the professor for his inspection. Last year's summer school was devoted to the study of the mining of the clay-band and hæmatite iron-ores of the North of England, and the coal-mining methods of Cumberland, Northumberland and Durham. This year, the students specialized in gold, manganese, lead and slate mining in North Wales, as well as carrying out a topographical survey and railway-traverse for some miles through mountainous country.

Occasional Visits to Mines.—Besides the summer school, numerous visits to the collieries and other mines of the Midlands are made during the session.

Practical Surveying.—Underground surveying, and the modes of connecting surface and underground surveys will be carried

out in the experimental mine, now nearly completed, which for this purpose alone will constitute a most valuable piece of apparatus.

The Equipment.—Elevations and a ground plan of the Applied Science Buildings at Bournbrook are shewn in Figs. 1 and 2 and Fig. 3 (Plate XIV.).* It will be observed that the plan is so designed as to allow of allocating a separate block to distinct subjects, with a central hall common to all the sections of applied science. All the blocks radiate from, and are connected together by a large semicircular corridor.† Besides these blocks, there are sundry outside buildings: the power-station, foundry, fitting-shop, and the smelting section of the metallurgical department. As, however, the metallurgical, civil, mechanical and electrical engineering branches are under the guidance of other professors, and do

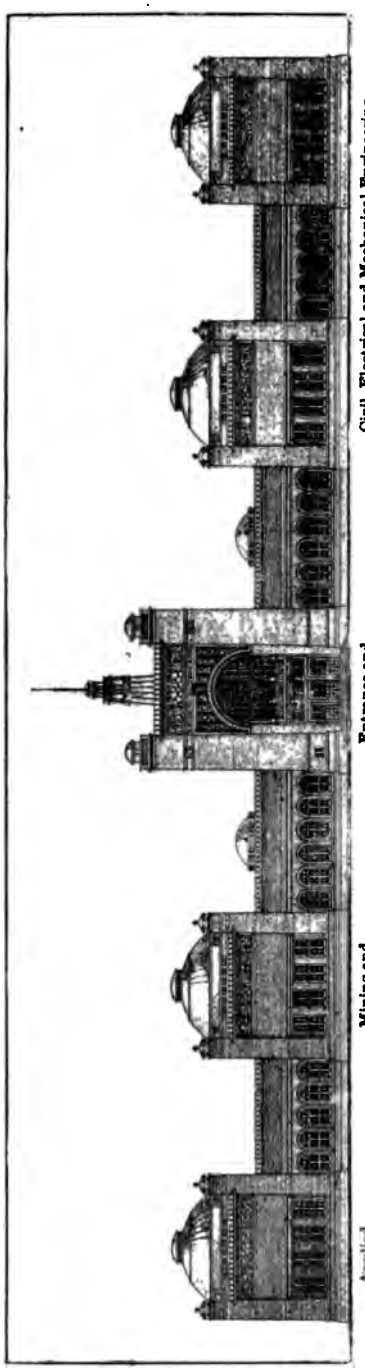
Civil, Electrical and Mechanical Engineering Blocks.
Entrance and Great Hall.
Mining and Metallurgy Block.
Applied Chemistry Block.

FIG. 1.—ELEVATION OF THE NORTH OR ENTRANCE FRONT OF THE UNIVERSITY OF BIRMINGHAM.

* Reproduced by permission from *The Building News*, 1902, vol. lxxxiii., page 363.

† The buildings to be erected first are lined in black on the ground-plan.

FIG. 2.—ELEVATION OF THE SOUTH FRONT OF THE UNIVERSITY OF BIRMINGHAM.

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(3) *Departmental Library.*—This library is a great desideratum, and although a good beginning has been made both by purchase and with several valuable presentations, it will be a matter of more or less slow growth. Within the past two years, a fairly good collection of books, plans, etc., has been got together. It is intended to extend the collection and make it of such a nature that it may attract not only students, but all persons interested in mining throughout the Midlands for the purposes of reference and consultation, and form a centralizing point for local and world-wide mining literature.

(4) *A Class-room* for the instruction of advanced students, which will also contain the surveying instruments in use and some of the models in daily use.

(5) *The Small Coal-mining Research Laboratory and a Photographic Dark-room.*—In the former, research work in mineral fuels, and other experimental work germane to coal-mining, will be carried out by advanced students, and instruction given in testing the relative value of fuels, etc. It will contain also the frames for tracing and photographing negatives, and large vats for developing prints, drying racks, etc.

(6) *The Large Coal-mining Research Laboratory* in which many operations relating to coal-mining will be practically demonstrated, and experiments carried out by the students, such as the construction and working of machine-drills, coal-cutting machinery, socketting of ropes, determination of the strength of materials (such as ropes, girders, props and wooden beams), and the construction and testing of safety-lamps. Apparatus for some of these purposes is either now under consideration, or being designed. Additional laboratory instruction and experimental research-work will be carried on in the experimental coal-mine placed outside the building.

(7) The cross or end part, Figs. 4, 5 and 6 (Plate XIV.), contains (1) the large metal-mining research laboratory (the largest individual mining laboratory in the world), (2) a smaller mechanical assay laboratory, in which instruction and experimental work will be carried out on a few ounces of ore at a time with small hand-worked apparatus, and (3) a general store-room common to all of the mining laboratories.

Plant.—The following is a detailed description of the plant ready under order, and being constructed by Messrs. Fraser Chalmers, Limited, of Erith.

(1) *Large Laboratory.*—Crushers: a 7 inches by 9 inches dge crusher; and a No. 0 Gates crusher, with cast-steel head d liners.

Elevator: a belt-and-bucket elevator, about 20 feet between tres, with an 8 inches belt and 7 inches buckets for elevating crushed ore to the bin.

Stamp-mill: an improved Challenge ore-feeder of the sus- ded type, and tappet-driven. A three-stamp mill (the stamps ghing 250 pounds each), with timber frame-work of pitch- e, the copper-plates being electro-plated. The foundation- k for the stamp-mortar is built up of pitchpine (Figs. 7 and Plate XV.), arranged so as to take up (as far as possible) vibration due to the stamping.

Huntington mill: an improved Challenge ore-feeder of the k-type and pulley-driven; a 3½ feet Huntington mill, with ne of pitchpine; 3 sheets of copper, ⅛ inch thick, 42 inches and 36 inches wide, electro-plated with 1 ounce of silver square foot, comprizing an amalgamating-table, 9 feet long.

Sizers: a McDermott and a Browne hydrometrical sizer with e cones.

Vanners and dressing-tables: a 4 feet frue-vanner, with plain and legs, sills and concentrate-boxes; a Wilfley table, 3 wide and 8 feet long, with return-wheel elevator. A 12 revolving table or buddle, with sheet-zinc covering.

Rolls: a set of 16 inches by 10 inches Cornish rolls, with ed-steel shells, belt-driven.

Screen: a cylindrical revolving screen, 30 inches in diameter 84 inches in length, screen-covering in three sizes, making e products and oversize, with housing and spouts.

Elevator: a belt-and-bucket elevator, about 20 inches centres, a 6 inches belt and 5 inches buckets, for elevating the shed ore from the rolls to the screen.

Jigs: a three-compartment Hartz jig, with a body of tank- l, and brass screens; and a two-compartment Collom jig, with dy of tank-steel.

Ball-mill: a No. 0 Krupp ball-mill, on a cast-iron framing, tight and loose pulleys.

Amalgamating-pan, barrel, etc.: a 30 inches amalgamating-pan, a 24 inches by 30 inches amalgamating-barrel, a 60 inches settler, and a steam-jacket drying-table of steel-plate, with a steam-pipe coil; a Knowles vertical triplex pump, with plungers, 4 inches in diameter by 6 inches stroke, of the B style.

(2) *The Small Research Laboratory* will contain a 4 inches by $1\frac{3}{4}$ inches Blake hand-crusher, a sample-grinder, a set of shaking tables, 12 inches wide and 48 inches long, having a double-screen frame, arranged to be run by hand, twenty screens of assorted mesh of brass wire, all 12 inches by 48 inches, and one experimental hand-jig.

The plant in the large laboratory will be driven by electric motors, the power being conducted by cables laid from the power-house (Fig. 3, Plate XIV.), along a subterranean corridor, the arrangement of the shafting and pulleys being shown in Figs. 5 and 6 (Plate XIV.). The power required will not amount to more than 20 horsepower in all. The maximum quantity of water required would be about 200 gallons per minute, if all the large machines are going at once, but as this will never happen 150 gallons per minute, or even less, will be the most that is likely to be required at any one time. As this, however, is a very large amount of water, and more than it is desirable to draw from the city mains, it has been arranged to use the same water over and over again, passing it through a settling tank of about 2,000 gallons capacity, and elevating it to a distributing tank (Fig. 5, Plate XIV.) by means of a pump. Using the same water over again, involves the use of muddy water for washing, but as the ore will also be used over and over again, this muddiness will not increase. This arrangement is being pursued in the mining laboratories at Columbia University, New York City, and Prof. H. S. Munroe assured the writer that it had answered admirably. It is as well, of course, to treat but one kind of ore at a time, and to clean out all pumps, pipes and tanks before treating another ore, but at Columbia University this does not prevent them from using two or three machines simultaneously (on the same ore) if necessary.

The distributing mains will be large, some being as much as 6 inches in diameter, in order to keep the velocity-head low at all times, so that the discharge remains practically constant at any faucet, even if several are open and closed on the same line.

The Experimental Coal-mine.—The position of the experimental coal-mine, which is placed some few feet below the surface, and connected thereto by a downcast and upcast shaft is shewn in Fig. 3 (Plate XIV.). Fig. 9 (Plate XV.) is a plan of the experimental mine: the galleries were originally intended to be entirely constructed of brick-arching, but, as a matter of fact, the greater part is built of concrete, the roof being strengthened by steel-girders inserted in the concrete. The workings, the area of which somewhat exceeds ¾ acre, will be ventilated by a single-inlet Capell fan, 5½ feet in diameter, with bearings 3 inches in diameter and 13 inches long, half cased, and driven at 500 revolutions per minute by an electric motor of 20 horse-power, coupled direct; and the mine will be drained by a small electric pump placed at the bottom of the downcast shaft.

The chief use to which this piece of apparatus will be put, will be to enable practical instruction to be given in underground surveying and levelling, and connecting surface and underground surveys; and for demonstrating and investigating the peculiarities of mine-ventilation, such as the splitting of air-currents and directing their course, the resistance to air-currents, the loss of pressure due to friction, and the characteristics of mechanically produced ventilation. The fan-house is being constructed so that three fans of different types, if need be, can be run at the same time. The resistance to the air-currents can also be considerably varied by the insertion in the mine-galleries of movable shutters, A,A,A, arranged as shewn in Fig. 10 (Plate XV.), and suggested to the writer by the Rev. G. M. Capell, who had put the idea into practice in a small model of his own, and found it to be very effective, inasmuch as they cause the air-current to take a longer route than otherwise. Regulating-doors, are also placed, so as to govern the quantity of air in the splits. Fig. 11 (Plate XV.) is a cross-section of the narrow bord at B, Fig. 12 is a cross-section of the longwall-face at C. Figs. and 14 are a cross-section and a side-elevation of an air-ing. Fig. 15 is a side-elevation of the upcast-shaft and the drift.

Among the further uses to which the experimental mine will ut, though these are quite secondary to the two described e, may be mentioned the demonstration of modes of tim-g, systems of haulage, and the conducting of experiments ation to these.

Prof. T. TURNER (University of Birmingham) said that, as the subjects of mining and metallurgy were so intimately connected, it had been suggested that some account of the Metallurgical Department of the University of Birmingham might conveniently accompany Prof. Redmayne's paper.

The department is divided into two sections, which, when taken together, offer facilities and provide equipment for the teaching of metallurgy on a scale which has not hitherto been possible in this country. One portion is still in process of erection, and will not be completed for about 9 months. It is on the upper ground floor and is situate above, and occupies the same area as, the Mining Department in block C. In this portion will be provided a large lecture-room; a laboratory for elementary teaching; a smaller one for advanced students; a furnace-room for dry-assaying and similar purposes; a room for sampling ores; another for preparing metals for analysis; a large, well-lighted balance-room; a pyrometric room; a micrographic room; and an electro-metallurgical room; together with other departments requisite for the accommodation of the professor and staff and for storage of apparatus, ores and chemicals. There will also be a large room on the upper floor suitable for museum purposes, while additional accommodation will be found for the storage of materials above the rooms in the radial arm.

The other section of the Metallurgical Department has been already completed, and a vacation course in practical metallurgy is in progress during the present meeting of the members. This section includes a separate building, 125 feet long, 50 feet wide and 27 feet high to the roof-principals. It is divided into two large and two smaller rooms, one large room being devoted to steel-manufacture and the other to the treatment of the ores of gold, silver, copper, lead, etc. The two smaller rooms are temporarily employed, one as a class-room and the other as an assay-office.

In the steel-section is a 2 tons Siemens furnace with a 10 cwts. electric hoist for raising material; a 3 tons hand-crane for dealing with the ingots produced; and a ladle travelling on rails above the ingot-pit. The moulds provided for ingots range from 5 inches square and 3 feet 6 inches long to 9 inches square and 4 feet 6 inches long.

During the vacation course, the students assisted in the roduction of charges of hard, medium and soft steel, and the ›urse also provided for the treatment of a North Wales lead-·e in a water-jacketted blast-furnace and a New South Wales ›ld-ore in the cyaniding plant.

Among the apparatus included in the non-ferrous section ay be mentioned a British cupellation-furnace; a flat-bottom ıleiner; a Bruckner roaster; a chlorinizing plant and a filter-·ess equipment, so that all the methods which may be regarded ı most important and typical can be experimentally demon-rated. Each piece of apparatus is sufficiently large to be ·tually used in a small works, and the whole equipment not ıly offers students an excellent opportunity of observing opera-ons on a considerable scale, but it supplies them with a metal-rgical museum of a kind which is of the greatest possible use r teaching purposes (Figs. 16, 17, 18 and 19, Plate XVI.).

The vacation course held in September in the smelting ction afforded an opportunity of trying the new plant and achinery. The students derived much useful and practical .formation from their work, and the result was very gratifying ı those who had been responsible for the designing and erection ? the plant.

Mr. M. H. Mills (Mansfield) said that Birmingham people ere justly proud of their University, but they must not be ırprised if mining engineers criticized the work that they ·ere doing. Young people sent to the University could not e expected to be thrown here and there in a large city like ›irmingham; and it would be necessary that some arrange-ıent should be made for housing the students. No provision ppeared to have been made for teaching foreign languages; nd he thought that the advantages of a knowledge of a little 'rench or Spanish would be recognized by all. He thought that he University authorities had a right to expect that the large olliery-owners of this district and of Britain generally should ome forward to the assistance of what would undoubtedly be he mining university of Britain.

Mr. George J. Binns (Duffield) asked whether the professors ad made up their minds as to whether a student should go to the 'niversity before commencing pit-work, or afterwards. He

confessed that, although he had given much thought to this matter, he had not yet arrived at a definite conclusion. There were no evening classes, and consequently it was not possible for a student to attend pit-work during the day and college classes in the evening. He could hardly agree that the teaching of foreign languages should be made part of the curriculum of a mining university, as there were opportunities elsewhere for learning languages, and preferably abroad.

Mr. W. N. Atkinson (H.M. Inspector of Mines, Barlaston) said that now there was such an admirable mining college in the Midland district, so admirably fitted up, and provided with professors of the highest standing, and in fact with every provision made for the thorough teaching of scientific mining engineering, the future success of the Mining Department of the University would largely depend upon the members of The Institution of Mining Engineers, because it was from the ranks of the Institution that the students must come; and the supply of students was, of course, one of the most important elements in the success of the scheme. He felt inclined to urge that every member of the Institution, who could do so (either to students or the older members), should take advantage of the education provided by the Birmingham University, as there could not be the slightest doubt that it was only by increasing the scientific knowledge of the members of the mining profession that we would be able to hold our own against foreign competitors, and to take the fullest advantage of the natural provision of minerals which had been accorded to this country.

Mr. Charles Chandley (Nottingham) said that a mining engineer was not of the slightest use unless he could produce coal at a price that could compete favourably with other producers; and that part of the question of mine-management did not seem to have been considered by Prof. Redmayne in his scheme. He advised that the University of Birmingham should send forth a prophet to preach to the colliery-owner that the teaching that students got in the Mining Department would tend towards the reduction of the cost of working; and it seemed to him (Mr. Chandley) that the colliery-owner should be educated as well as the student. Mr. W. N. Atkinson had referred to the supply of young men for such a college, but as soon as there was a demand for efficiently-taught and efficiently-trained

mining engineers, the students would appear rapidly enough. He (Mr. Chandley) might point out that it was an immense advantage to an engineer to know the Spanish words, say, for ore, refuse, etc., which he would readily acquire at the college, but which could not be learnt at any of the schools of languages.

Mr. SYDNEY F. WALKER (Bath) said that the University of Birmingham was to be congratulated on the thoroughly practical lines upon which the Mining Department had been laid out; but on the other hand, technical education generally (in other branches at all events) had not been all that it should be. When a student left a college he should know familiarly every detail of every part of the construction of every kind of apparatus that he was likely to encounter, and he should be able to give a reason for every detail of its construction.

Mr. J. S. MARTIN (H. M. Inspector of Mines, Bristol) regretted to hear the remarks of the last speaker so strongly deprecating scientific and technical education. Looking abroad, whither so many South Wales mining engineers have, at length, been turning their attention, they found exactly the opposite result to what they had just heard. Whatever miners, including mining engineers, may be in politics, they were in their profession, the most conservative class of men that existed. If they looked back to Germany some 35 years ago, when he (Mr. Martin) was employed at some of the pioneer collieries in Westphalia, it would be recognized that Britons had taught the Germans the practical art of mining. He was employed by a company which brought Mr. William Coulson from the North of England to sink their shafts. The Germans were ready to learn what was being done in Britain, and came over to England in large numbers; they had applied British practice to their German theory, and thus, while we were sleeping as the result of self-conceit, they had left us behind. Abroad the difficulties were far greater than they were in this country, owing to the contortions and steepness of the measures; while here we were most fortunately situated with regard to our flat coal-seams, abroad they had no such thing as a flat seam; they also had few clean seams of the same quality as our South Wales steam coal. It was the application of practice to theory, derived from scientific education, that had produced

vourable results in Germany. He (Mr. Martin) still to see Britain, now awakening to a sense of the necessity hnical and scientific education, holding its own position in orld, by means of the combination, as otherwise, we should be left far behind in the race that we were trying to run.

Mr. W. Price Abell (Duffield) said that colleges meant ecialization of teaching, and all practical men knew that ecialization in practice meant reducing the cost of production. his theory of specialization or system was at the root of all uccessful professional business. As an instance, very few engineering works in Glasgow would now take on premium pupils through their so disorganizing their manufacturing pro- gress; hence as a natural consequence systematic training came in as an auxiliary to systematizing practical work, not inde- pendent of it but as a great help to its efficient organization and consequent cheapening of whatever work was in hand. This auxiliary technical training enabled the students to systematize and organize work in the future. He (Mr. Abell) did not attach great importance to the question as to whether it was advisable for a student to attend a college, before or after engaging in practical work, so long as the theoretical and practical training were commingled. It was better if this could be done weekly; but it was certainly sufficient if it could be done even yearly. In his experience, the best plan was to have 12 months in the drawing mine or engineering-shops and then 12 months in the drawing office and college. At the same time, it was advisable that a refined student should be let down easier than by taking him straight from school without some slight preparation for the rough work that he would meet with in either the shop or the mine. Doubtless this commingling of the college training with practical work, enhanced the faculty for systematizing and organizing that was so necessary for the success of the professional business-man. The success that had attended practical specialization led him to believe that success would also attend the specialization of teaching, such as obtained in the Mining Department of the University of Birmingham.

Mr. G. Elmsley Coke (Nottingham) expressed agreement with Mr. Abell that the practical and theoretical training of engineering students should, to some extent, be carried on

currently. For mining students, it would be an improvement in the otherwise excellent engineering courses at Birmingham and other mining schools, if special arrangements were made to enable the student to divide his time between theoretical work of the college and practical work at the colliery.

Prof. HENRY LOUIS (Armstrong College, Newcastle-upon-Tyne) congratulated Prof. Redmayne on the excellent equipment of the new Mining College, and also the Midland counties on a very much needed piece of work. They did not realize in this country how deficient they were in mining colleges throughout the kingdom, but the visit of their Belgian friends to-day might help them to realize it, for here were sixty mining engineers, who were all students at one single school in the small kingdom of Belgium. We could not shew anything of that kind, and our mining interests were, at all events, comparable with those of Belgium in importance. There ought to be a college at least as well equipped as that of Birmingham in every coal-mining district of this country. He did not propose to criticize Prof. Redmayne's curriculum, although he might say that he differed from him in very many points of detail. It was a good thing to have such divergence of views, and he would be sorry indeed if the time ever came when all the teaching of technical science in a country like ours was run on identical lines and bound by cast-iron methods. It was desirable that men, who had the drawing-up of curricula like this, should follow their own lines and adopt different methods, for by the experience thus gained they would hit upon improved methods. He was entirely opposed to any slavish imitation of the systems adopted in Germany, America, or any other country. There were, however, two points in the scheme of instruction to which he would like to draw attention. He did not suppose that it was intended to suggest that any man who had taken the degree of bachelor of science at Birmingham was thereby considered competent to teach mining; but, if that were the view, he entirely dissented from it: no man should be allowed to teach mining until he had had many years' experience in managing mines. He (Prof. Louis) was afraid that the practice was beginning to prevail of graduates of colleges being looked upon as qualified to teach mining; this would do very

much harm. The graduate should first have the opportunity of finding out for himself how theory was to be applied to practice, before attempting to instruct others. He (Prof. Louis) also wished to record emphatically his dissent from a statement made by the professor of engineering and his objection to the idea that an engineering course was to prepare students so as to render them at once serviceable in engineering works; in his own opinion this was impossible, and if it were possible it would not be advisable. The right function of an engineering college or technical university was to prepare the students leaving that institution to benefit by their technical training, but to imagine that any amount of college-training could fit a man to take any position in practical life was a mistake; all it could do was to fit him to learn in time to take that position, far more thoroughly and usefully than one who had not had the same college training. To have different views on these points, however, was perfectly natural, for just as mining engineers would have different views as to how a particular coal-field should be developed, when developing such an intangible subject as the human intelligence, it was natural that the views would be still even more divergent.

Mr. Sam. Mavor (Glasgow) asked whether colliery-owners in this country would consider it practicable to permit employés to adopt the "sandwich" system, as in the case of other engineering centres, where they had 6 months in the summer of practical work and 6 months in the winter of study at the University.

Mr. E. L. Corthell (New York, U.S.A.) wrote that the description of the Mining Department of the Birmingham University showed it to be in its scope and method one of the most complete to be found anywhere. The arrangements for practical teaching were admirable. The plan of having the "degree students" matriculated in the faculty of science before entering upon the course of study for the degree, was an excellent idea. The plan of having an experimental mine for illustrating and studying methods of underground survey, and particularly the mode of connecting surface and underground surveys, was also excellent. The arrangement for a coal-mining laboratory and employing a real experimental mine were both features of very great utility in the practical teaching of such studies.

There was nothing to criticize, but everything to approve of, in the establishment, and he would be greatly pleased, at some time when visiting Great Britain, to make a personal inspection of the department.

Prof. F. W. Hardwick (University College, Sheffield) wrote that he had been greatly interested by Prof. Redmayne's account of the steps which were being taken at the University of Birmingham to promote the interests of mining education. The paper was not, like many on the subject which had come before the Institution, a mere exposition of ideal views held by the writer about technical education in mining, but was a description of what was actually being done; and all who were interested in the education of mining engineers must be greatly indebted to Prof. Redmayne for his paper.

The writer was interested to notice that the Mining Department of the University of Birmingham confined its work entirely to regular day students of the University. At University College, Sheffield, this was not the case. The College was closely associated with the county councils of the West Riding of Yorkshire and of Derbyshire, and assisted in carrying out their scheme of mining education. At first, instruction in mining had been given by lecturers on the staff of the Mining Department in both counties by short courses of lectures in the various mining towns and villages, and in the southern portion of the West Riding a few of these courses were still given annually; the bulk of the elementary education in mining was, however, in both counties, now given in local mining classes, which were supported by grants from the county councils and from the Board of Education, while the College was entrusted with the important work of organizing, inspecting, examining and reporting on these classes. The instruction was given in the West Riding, and, as a rule, in Derbyshire, under a special syllabus which combined, not only mining, but such subjects as applied arithmetic, mensuration and elementary applied science. The teachers were nearly all practical men, occupying official positions in collieries in the neighbourhood of the place where the class was held, and as it had been found that in many cases those who were most competent to instruct such classes were not able to impart their knowledge in the best way,

a class for mining teachers had been carried on for some years at the College, in which either teachers of existing classes, or men who desired in the future to take charge of a class, were instructed in the art of teaching, and in the setting up of apparatus and performing experiments which would illustrate the subjects treated. In Derbyshire, these classes had been most successful, and although at present they were not equally numerous in the southern portion of the West Riding, yet there were encouraging signs that even there the work done in these classes was beginning to be appreciated. The best students from these local classes were sent to the College Saturday afternoon course in mining, with exhibitions from the county councils, and to this course were also sent successful candidates chosen by an examination, and from the external lecture-courses carried on by the College. This Saturday course occupies 4 hours each Saturday afternoon during the session for 2 years, and has of late years been supplemented by a 2 year course in electricity applied to mining, and by the mining teachers' course mentioned above. These courses were numerously attended, and formed an additional link between the College and the district around Sheffield.

As soon as the work of mining instruction had been founded on the broad basis indicated above, attention was turned to the need for a higher class of mining instruction to day students, suitable to articled pupils, and to any students who could spare the necessary time. In the session 1896-1897, an advanced mining course was commenced, which required students to attend the College for 5½ days per week in the first year, 2 days per week in the second year, and 2 days per week in the third year: at the close of the first year, students were articled at a colliery in the neighbourhood of Sheffield, and spent the remainder of the time not occupied at the College in the second and third years at the colliery. In this way, it was hoped that the instruction given at the College might be best appreciated by students simultaneously seeing its practical application at the colliery. Recently this advanced course has been abolished and its place taken by the diploma course, as mentioned below.

At the present time, therefore, the work of the Mining Department of University College, Sheffield, consists of (1)

supervision and active work in mining instruction in the adjacent counties; (2) Saturday course in mining, mechanics, chemistry, machine-drawing, steam and surveying; courses in electricity applied to mining; and a course for mining teachers: this division of the work being analogous to the evening work mentioned by Prof. Redmayne; and (3) the diploma course in mining for day students. In the two first named branches, the work is done jointly with the county councils; the third branch is one for which the College alone is responsible.

The writer ventures to think that an arrangement of this kind is more satisfactory, and fulfils better what may be taken to be the rôle of a local University or University College than the one mentioned in the paper. A frequent argument in favour of the establishment of local Universities is that it will bring the best instruction near to persons in the provinces who would otherwise be deprived of it; but the majority of such people are in positions which render it impossible for them to attend any but evening classes. The writer has found that the students who attend the Saturday classes are among the best that he has. Their excellent behaviour, dogged determination to learn, and perseverance have commanded the respect of all who have to deal with them; surely an educational institution which does not receive such students is hardly making the most of its opportunities.

Prof. Redmayne mentioned that some of the students from the county-council classes "naturally proceed to the University," and the writer was very anxious to know how this is managed. As shewn above, a regular chain of instruction in mining is carried out at University College, Sheffield, but any link to connect the Saturday classes with the day courses of instruction is missing. In order to attend the day courses, the students must leave their work, if not every day in the week, at all events for at least 2 days per week, and very few of them can afford to do so. A man in the position of a deputy cannot ask to leave work for 2 days in every week for a number of years to attend college courses, nor can an official or collier with a wife and family to support attempt to do so. A few of the Saturday students might, and undoubtedly should, attend the day courses, but in most cases it is impossible. The writer remembers only one instance in which the difficulty has been met, when a student,

king in the pit on the night-shift, attended the College day rse for 2 days in the week. The rarity of the case, however, proves the existence of the difficulty.

Table I. shews the numbers enrolled under each of the various ivisions of the work done by University College, Sheffield, uring the years in which each course has been in existence.

TABLE I.—UNIVERSITY COLLEGE, SHEFFIELD.

Course.	Number of Years that the Course has existed.	Number of Students enrolled.*
Advanced day students	8	50
Certificate course (Saturday afternoons) ...	13	968
†Derby mining course (Saturday afternoons)	10	287
Mining electricity course (Saturday afternoons)	5	143
Mining teachers' course (Saturday afternoons)	6	61
‡Extension lectures in the West Riding (southern portion)	13	2,453
‡Local classes in the West Riding (southern portion)...	6	1,928
Local classes in Derbyshire	10	4,877

* These are not individual students, but the aggregate of the numbers enrolled for each year.

† A course is held at Derby by the college on Saturday afternoons, similar to the course at Sheffield.

‡ The University of Leeds takes the northern portion, and University College, Sheffield, the southern portion of the West Riding of Yorkshire.

Table I. shews clearly how the University College of Sheffield has been able to extend its influence and the area of its teaching by taking evening students (that is, the Saturday afternoon classes), and by associating itself with the county councils in their work of local mining instruction. If these local educational institutions are really of value, the wider the area over which their teaching and influence can be spread the better, and there seems no just cause why their work should be limited to one class of students or to one class of instruction.

An arrangement of this kind also minimizes the danger of "overlapping," which is almost certain to exist when mining education is being carried on under two different authorities. In Britain, where educational institutions have so often been commenced by private enterprise, there has doubtless been a considerable waste from this cause both of money and energy in education.

The writer was also much interested in the diploma course in mining, which had been drawn up by the University of Birmingham. The same subject had claimed the attention of the Coal-mining Committee of University College, Sheffield, and

after consultation with the Senate they had decided to abolish the existing advanced course, and to substitute for it a diploma course, in which more thorough instruction could be given. As the new course had met with some criticism, the writer had prepared comparative tables (Tables II. and III.) of the diploma courses and regulations adopted by twelve educational institutions, whose diploma courses in mining had been recognized by the Home Secretary as complying with the Coal-mines Regulation Act, 1887, Amendment Act, 1903. As the standards differed somewhat, and as the weight attached to certain subjects appeared to differ a good deal, it might be interesting to members of the Institution to examine the tables, which were compiled by the writer from the calendars of the universities and Colleges mentioned, and were possibly not free from error; they would, however, show the impression gained by a study of the courses and regulations by a person acquainted with them.

Prof. Redmayne was fortunate in having the means at his disposal to equip his department thoroughly. He (Prof. Hardy) was rather inclined to wonder whether the experimental coal-mine would yield results proportionate to its cost, and to what extent any tests on ventilation, etc., made in it would be useful in practice. Undoubtedly actual tests in collieries would be of greater value, but there was always the difficulty that the students' time was lost in getting to and from the colliery, and this, during term-time, was a serious matter; the experimental coal-mine had, however, the advantage of being close to the University.

Mr. John H. Merivale (Broomhill) wrote that Prof. Redmayne's paper was very instructive and should receive careful consideration from everyone interested in mining education. Leeds and the University of Birmingham, were to be congratulated on their decision to have, not only a complete course of lectures, but also a well-equipped mining laboratory. This, he (Mr. Merivale) believed, did not at present exist in Britain; and yet it formed a very important part of the mining department of a science college. Valuable and necessary as were lectures, a student could not derive full benefit from them without the opportunity of putting to a practical test in the laboratory what he had heard in the lecture-theatre.

TABLE II.—CURRICULUM OF THE DIPLOMA COURSES AT EDUCATION

UNIVERSITY OF BIRMINGHAM.	UNIVERSITY COLLEGE, BRISTOL.	ARMSTRONG COLLEGE, IN THE UNIVERSITY OF DURHAM.
No entrance examination.	(*Senior Diploma.*) Preliminary examination is not obligatory, but recommended to all technical students:—(1) English, including geography, history and literature; (2) mathematics, including algebra to quadratic equations and the binomial theorem, plane trigonometry and elementary geometry; and (3) two of the following subjects, not more than one of which shall be a language: (*a*) Latin, (*b*) Greek, (*c*) French, (*d*) German, (*e*) elementary physics, (*f*) elementary chemistry, (*g*) geometry and freehand drawing.	No entrance examination.
First Year:	*First Year:*	*First Year:*
Hours.	Hours.	
Mathematics, course i. 4	Engineering 3	May be spread over more than one year.
Physics, course i. ... 3	Mathematics... ... 5	Hours.
Physical laboratory 2	Physics and physical laboratory 5	Mathematics, first year ... ...
Geology, course i. ... 6	Mechanics 2	Physics, first year ...
Mining, course i. ... 2	Mechanical drawing 8	Physical laboratory
Surveying 2	Engineering laboratory and workshop 6	Chemistry, first year
	Surveying, one term only ... ... (5)	Chemical laboratory 6
		Geology 2
		Geological surveying 6
Hours per week 19	Hours per week 29	Hours per week 31

'S APPROVED BY THE HOME SECRETARY.

ERSITY OF ASGOW.	GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.	UNIVERSITY OF LEEDS.
s for the certificiency have riculate. Their of education, must be up to rd required in ulation exam- the subjects the mining s, in the final ons, students ake the same hose set for the B.Sc.	Entrance examination, comprising: (1) English and composition, grammar, and geography of the British Empire; (2) mathematics: arithmetic, geometry (Euclid, books i., ii. and iii.), and algebra (to quadratic equations); (3) freehand drawing; (4) Latin or a modern language; (5) mathematics (optional), geometry, algebra, trigonometry; and (6) engineering drawing (optional).	Entrance examination in arithmetic, algebra, and geometry.
t Year:	*First Year:*	*First Year:*
Hours.	Hours.	Hours.
ics... ... 5	Natural philosophy, i. 5	Physics, course i. ... 3
ilosophy.. 5	Inorganic chemistry, i. 5	Chemistry, course i. (two terms) ... 3
... ... 5	Mathematics, i. ... 5	Mathematics, course ii. 3
laboratory 6	Mechanics, i. ... 2	Engineering, course i. 3
... ... 2	Physical laboratory ... 3	Coal-mining 1
	Chemical laboratory 3	Chemical laboratory 3
	Engineering drawing 8	Physical laboratory 2
		Engineering laboratory 6
		Engineering drawing 5
		Electrical engineering laboratory ... 2
rs per week 23	Hours per week 31	Hours per week 31

TABLE II.—CURRICULUM OF THE DIPLOMA COURSES AT EDUCATION

ROYAL SCHOOL OF MINES, LONDON.

No candidate for the associateship will be admitted as a fee-paying student unless he has obtained a first class in the first stage of mathematics or practical mathematics; practical plane and solid geometry, theoretical mechanics (solids), theoretical mechanics (fluids), inorganic chemistry (theoretical), sound, light and heat, and magnetism and electricity, or a pass in some higher stage of those subjects at the examinations of the Board of Education.

First Year:

	Hours.
First term: Chemistry, part i. / Second term: Physics, part i.	5½-6
First term: Chemical laboratory, part i. / Second term: Physical laboratory, part i.	16-19
Mathematics, A ...	4
Drawing, unless previously qualified	3
Average hours per week ...	29

UNIVERSITY OF OXFORD.

The diploma in scientific engineering and mining subjects is granted to members of the University, who have passed all the examinations required for the degree of B.A., and have satisfied the examiners in certain special diploma-subjects included in the subjoined list (or have passed certain equivalent examinations), after an approved course of study in those subjects extending over two years, and have also gone through an approved course of practical training, during four months, either at a mine or in engineering works.

Subjects:

(*a*) Mathematics, for applied science.
(*b*) Physics and chemistry.
(*c*) French and German translation.
(*d*) Engineering principles and machine-drawing.
(*e*) Surveying.
(*f*) Geology.
(*g*) Mineralogy.
(*h*) Mining and engineering hygiene and mine-ventilation.
(*i*) Electricity.
(*j*) Assaying.

UNIVERSITY COLLEGE, SHEFFIELD.

Preliminary Year:

Every day at the college—

	Hours.
Physics, courses i. and ii.	4
Physical laboratory	2
Chemistry, course i.	3
Chemical laboratory	6
Mathematics ...	8
Machine-drawing ...	3
Workshops	
Hours per week	30

Students who can pass an examination in physics, chemistry and mathematics, and have been educated at an institution recognized for the purpose by the Senate, are excused the preliminary year.

First Year:

Two days per week at the college, and the rest of the time at a colliery.

	Hours.
Applied mechanics ...	2
Steam	2
Electrical engineering	2
Mining chemistry ...	3
Engineering laboratory	3
Mine-surveying ...	
Hours per week	14

NS APPROVED BY THE HOME SECRETARY.—*Continued.*

ITY COLLEGE OF H WALES.

ce examination ish, arithmetic ra.

st Year :

	Hours.
... ...	3
eying ...	5
... ..	2
geology ...	4
ng	2
... ...	5
chemistry	6

rs per week 27

WIGAN MINING AND TECHNICAL COLLEGE.

Entrance examination in English, mathematics, freehand drawing, general elementary science, and a language.

Preliminary Course :

	Hours.
Mathematics... ...	6½
Physics	2
Physical laboratory...	4
Ambulance	1
Chemistry	2
Chemical laboratory	4
Drawing	10
Wood workshop ...	2
Hours per week	31½

First Year :

	Hours.
Practical mathematics	4
Chemistry	3
Physics	3
Mining	3¾
Ambulance	1
Mechanical engineering	8
Geology and mineralogy	2⅓
Geological laboratory	4
Workshop	2
Hours per week	31½

UNIVERSITY OF CAMBRIDGE.

The details of the diploma course have yet to be arranged, but the following is an outline of the recommendations of the Syndicate on Instruction in Mining Engineering.

The diploma course is to contain optional additions to meet the case of students in metalliferous mining.

A candidate for the diploma course should be able to take honours in the natural sciences tripos or in the mechanical sciences tripos: for this reason, no definite order or time is laid down for taking the examinations. Under the proposed regulations, a candidate may take as the final examination for his degree either the natural sciences tripos, or the mechanical sciences tripos, or the special examination in applied sciences.

The diploma will be granted to students under the following conditions:—

1. The student shall have passed the previous examination, parts i. and ii., or any examination recognized in lieu thereof, and completed nine terms of residence.

2. The student (*a*) shall have reached the standard required for honours in the examination (papers and practical work) in chemistry and geology in the natural sciences tripos. (*b*) Shall have reached the standard required for a second class in the examination in structures, heat-engines, and electricity (papers

ONS APPROVED BY THE HOME SECRETARY.—*Continued.*

VERSITY OF LASGOW.	GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.	UNIVERSITY OF LEEDS.
ond Year:	*Second Year:*	*Second Year:*
Hours.	Hours.	Hours.
ing, class i.,	Mathematics, ii. ... 4	Mining 3
ts of applied	Fuels and oils ... 2	Metallurgy (first term) 2
ics and the	Materials of construction... 1	Geology, course i. ... 3
als of con-	Electrical engineering, i. 2	Geological laboratory 3
on 5	Thermodynamics ... 1	Electrical engineering laboratory ... 3
ing, class ii.,	Mechanics 3	Mining laboratory and mine-surveying ... 15
ing 3	Prime movers, i. ... 2	
ing, class iii.,	Coal-mining 1	
movers and	Geology and mineralogy 2	
ics of ma-	Geology and mining, laboratory and drawing 12	
... ... 3		
... .. 2		
and miner-		
... ... 4		
ing drawing 6		
Hours per week 23	Hours per week 30	Hours per week 29
ird Year:	*Third Year:*	
Hours.	Hours.	
l engineering 3	Mathematics, iii. ... 5	
gy 2	Electrical engineering, ii. 3	
gical labora-	Electrical engineering laboratory... ... 5	
... ... 6	Metallurgy, i. ... 2	
ing labora-	Metallurgical laboratory... 7	
... ... 6	General mining .. 2	
... ... 1	Geology and mining, laboratory and drawing 8	
urs per week 18	Hours per week 32	
ssion consists of .	The session consists of 25 weeks.	The session consists of 32 weeks.

TABLE II.—CURRICULUM OF THE DIPLOMA COURSES AT EDUCATIONAL

ROYAL SCHOOL OF MINES, LONDON.	UNIVERSITY OF OXFORD.	UNIVERSITY COLLEGE, SHEFFIELD.
Second Year:	Candidates, who desire to become colliery engineers, and to obtain exemption, under the provisions of the Coal-mines Regulation Act (1887) Amendment Act, 1903, from two of the five years' underground work required under the Act as a qualification for a certificate as colliery manager, must obtain a special form of diploma, B, by passing the diploma examinations in the following subjects (or their equivalents): — (*a*), (*b*), (*c*), (*h*); and three of the following: (*d*), (*e*), (*f*), (*g*), (*i*), (*j*), provided that the combination (*f*), (*g*), (*i*) be not taken without one or more of the others; and by taking the four months' course of practical training at a mine. Certain examinations are accepted as equivalents of the diploma examinations in some of the subjects.	*Second Year:* Two days per week at the college, and the rest of the time at a colliery.
Hours. First term: Mechanics, part i. 5 Mechanical laboratory, part i. 10 Machine-drawing 6 Second term: Geology and mineralogy, with additional demonstrations subsequently in illustration of the lectures ... 5 Geological and mineralogical laboratory ... ... 15 Applied electricity 1 Electrical laboratory ... ... 3 Graphics and practical geometry ... 3 Average hours per week ... 27-28		Hours. Applied mechanics ... 2 Steam ... ... 2 Mining ... ... 2 Mathematics ... 2 Electrical engineering 2 Electrical laboratory 4 Hours per week 14
Third Year: Hours. First term: Metallurgy and assaying Second term: Mine-surveying, with 6 weeks' work at mines in addition to field-work in or near London } 21-23 Mining lectures, including surveying and metallurgy, part i. ... 8-10 Average hours per week ... 31		*Third Year:* Every day at the college. Hours. Ambulance ... ... 1 Mining chemistry 6 Mining ... ... 4 Electrical engineering 2 Electrical laboratory 3 Geology ... ... 2 Engineering laboratory 6 Mine-surveying ... 3 Hours per week 27
The session of 2 terms comprizes about 33 weeks.	The session consists of 24 weeks.	The session consists of 37 weeks.

TIONS APPROVED BY THE HOME SECRETARY.—*Continued.*

ERSITY COLLEGE OF OUTH WALES.	WIGAN MINING AND TECHNICAL COLLEGE.	UNIVERSITY OF CAMBRIDGE.
Second Year:	*Second Year:*	and practical work) in the second part of the special examination for the ordinary B.A. degree in mechanism and applied sciences. Candidates who have reached the standard required for honours in the examination in these subjects in the mechanical sciences tripos shall not be required to take the special examination. (*c*) Shall have obtained a certificate from the professor of mechanism of a satisfactory knowledge of elementary mechanical drawing. Certain exemptions are provided from practical examination in the subjects in (*a*) and (*b*).
Hours.	Hours.	
... ... 3	Mining 3	
urveying ... 8	Mining laboratory ... 4	
y 8	Surveying and office-work 4	
ering laboratory 3	Metallurgy 2	
urgy and assay- 6	Metallurgical laboratory... 4	
	Mechanical engineering 2	
	Electrical engineering 4	
	Geology and mineralogy 3	
	Geological laboratory 2	
	Ambulance 1	
Hours per week 28	Hours per week 29	3. The student shall obtain a certificate from a responsible mining engineer, that he has spent not less than four months in actual work under his supervision in or about a mine, and has acquired a satisfactory knowledge of surveying in mines.
	Third Year:	
	Hours.	
	Mining 3	
	Mining laboratory ... 7	
	Surveying and office-work 6	
	Electrical engineering 3	
	Metallurgy 1	
	Assaying 8	
	Hours per week 28	4. The student shall give satisfactory evidence of a knowledge of the application of science to the art of mining, according to regulations to be laid down by the special board for physics and chemistry.
	On Saturdays in each year, occasional visits to collieries in the district. In the summer of the third year, special course in surveying.	5. Entries may be made on the diploma certifying proficiency in one or more of the following subjects:—mineralogy, metallurgy and assaying.
session consists of eks.	The session consists of 25 weeks.	The session consists of 24 weeks.

TABLE III.—REGULATIONS OF THE DIPLOMA COURSES

UNIVERSITY OF BIRMINGHAM.	UNIVERSITY COLLEGE, BRISTOL. (*Senior diploma.*)	ARMSTRONG COLLEGE, THE UNIVERSITY OF DURHAM.
No entrance examination for the diploma course. Students who wish to obtain a certificate in coal-mining, such as to fit them for colliery management, must take the lecture and laboratory courses laid down for the first and second years, together with certain lectures and laboratory courses in the allied sciences. They must further have practical experience in a mine, for a couple of months at least in each year, or have had a minimum of 4 months of such experience prior to entering on the diploma course, to enable them to take the diploma in mining.	The preliminary examination is optional, but technical students are recommended to present themselves for it. The subjects are:—(1) English, including geography, history and literature; (2) mathematics, including algebra to quadratic equations and the binomial theorem, plane trigonometry and elementary geometry; and (3) two of the following subjects, not more than one of which shall be a language: (*a*) Latin, (*b*) Greek, (*c*) French, (*d*) German, (*e*) elementary physics, (*f*) elementary chemistry, (*g*) geometry and freehand drawing. During each summer vacation, at least two months must be spent at a colliery, the student receiving practical instruction and training. In order to obtain a diploma, students must (1) attend all courses satisfactorily and pass the sessional examinations not lower than second class; (2) at the end of the third year, pass special final examinations for the diploma; (3) produce evidence that the time spent at the colliery has been properly utilized, and that they have made satisfactory progress in practical knowledge.	No entrance examination for the diploma course. This course is arranged for two years, but students who have attended the course and have successfully passed the examinations, even though these be spread over three or more years, will be granted the diploma except in the case of those students who take the degree of bachelor of science in mining of the University of Durham, provided that the diploma shall not be granted to any student who cannot produce satisfactory evidence that he has spent at least 4 months in or about a mine. Students are strongly recommended to attend the ambulance class, classes in at least one foreign language, and in their third year an optional class in determinative blowpipe mineralogy. A knowledge of these subjects will be considered in granting the diploma.

AL INSTITUTIONS APPROVED BY THE HOME SECRETARY.

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le 26 weeks of r session must in practical colliery, or in gineer's office, y access to l all students ed to pass a nd final exam- ach subject, of tandard as for of B.Sc.

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

Students who desire to qualify for the diploma must pass an entrance examination in (1) English; (2) mathematics (3) freehand drawing; (4) Latin, or a modern language, may be deferred to any later date prior to a candidate's admission to the final diploma examinations; (5) mathematics and (6) engineering drawing are optional, but special arrangements are made in the departments of mathematics and engineering drawing for students who satisfy the examiners in these subjects.

Exemption from the entrance examination is granted to students who have passed an equivalent examination elsewhere.

The summer between the first and second sessions should be spent in work underground. In the following summer, attendance will be required daily at classes in surveying, in field-work, and in practical chemistry.

UNIVERSITY OF LEEDS.

Entrance examination in arithmetic, algebra and geometry. Students under the age of 17 take English composition and dictation in addition.

Students are required to obtain 4 months' experience at a mine during the vacations, or to have had previous experience at mines before entering on the course.

TABLE III.—REGULATIONS OF THE DIPLOMA COURSES

UNIVERSITY OF BIRMINGHAM.	UNIVERSITY COLLEGE, BRISTOL. (*Senior diploma.*)	ARMSTRONG COLLEGE, THE UNIVERSITY DURHAM.
No entrance examination for the diploma course.	The preliminary examination is optional, but technical students are recommended to present themselves for it. The subjects are:—(1) English, including geography, history and literature; (2) mathematics, including algebra to quadratic equations and the binomial theorem, plane trigonometry and elementary geometry; and (3) two of the following subjects, not more than one of which shall be a language: (*a*) Latin, (*b*) Greek, (*c*) French, (*d*) German, (*e*) elementary physics, (*f*) elementary chemistry, (*g*) geometry and freehand drawing.	No entrance examin tion for the diplo course.
Students who wish to obtain a certificate in coal-mining, such as to fit them for colliery management, must take the lecture and laboratory courses laid down for the first and second years, together with certain lectures and laboratory courses in the allied sciences.	During each summer vacation, at least two months must be spent at a colliery, the student receiving practical instruction and training.	This course is arrang for two years, but st dents who have attend the course and have su cessfully passed the e aminations, even thou these be spread over thr or more years, will granted the diplom except in the case those students who ta the degree of bachelor science in mining of t University of Durha provided that the diplo shall not be granted any student who can produce satisfactory e dence that he has sp at least 4 months in about a mine.
They must further have practical experience in a mine, for a couple of months at least in each year, or have had a minimum of 4 months of such experience prior to entering on the diploma course, to enable them to take the diploma in mining.	In order to obtain a diploma, students must (1) attend all courses satisfactorily and pass the sessional examinations not lower than second class; (2) at the end of the third year, pass special final examinations for the diploma; (3) produce evidence that the time spent at the colliery has been properly utilized, and that they have made satisfactory progress in practical knowledge.	Students are stron recommended to att the ambulance cl classes in at least o foreign language, and their third year an o tional class in determin tive blowpipe mineralog A knowledge of thes subjects will be con sidered in granting the diploma.

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GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

Students who desire to qualify for the diploma must pass an entrance examination in (1) English; (2) mathematics; (3) freehand drawing; (4) Latin, or a modern language, may be deferred to any later date prior to a candidate's admission to the final diploma examinations; (5) mathematics and (6) engineering drawing are optional, but special arrangements are made in the departments of mathematics and engineering drawing for students who satisfy the examiners in these subjects.

Exemption from the entrance examination is granted to students who have passed an equivalent examination elsewhere.

The summer between the first and second sessions should be spent in work underground. In the following summer, attendance will be required daily at classes in surveying, in field-work, and in practical chemistry.

UNIVERSITY OF LEEDS.

Entrance examination in arithmetic, algebra and geometry. Students under the age of 17 take English composition and dictation in addition.

Students are required to obtain 4 months' experience at a mine during the vacations, or to have had previous experience at mines before entering on the course.

TABLE III.—REGULATIONS OF THE DIPLOMA COURSES AT

ROYAL SCHOOL OF MINES, LONDON.	UNIVERSITY OF OXFORD.	UNIVERSITY COLLEGE, SHEFFIELD.
No candidate for the associateship will be admitted as a fee-paying student unless he has obtained a first class in the first stage of mathematics or practical mathematics; practical plane and solid geometry, theoretical mechanics (solids), theoretical mechanics (fluids), inorganic chemistry (theoretical), sound, light and heat, and magnetism and electricity, or a pass in some higher stage of those subjects at the examinations of the Board of Education. The associateship in mining will not be awarded to a student until he has completed, in all, 6 months' practical experience of underground work in a mine; of this, one-half at least must be completed before the student attends the lectures in mining; one-half of the whole time should have been spent at a colliery, and the other at an ore-mine. The 6 months' practical experience shall mean at least 120 visits underground, each lasting not less than 6 hours underground. The regulations provide that the practical work shall be under the supervision of the professor of mining, who knows at what mine each student is studying, and to whom the students' notes on the mine are submitted. In selecting a mine for practical work, the student should consult the professor of mining or the instructor in mine-surveying. *Continued at foot of page 499.*	A special diploma, B, is granted to those who desire to become colliery engineers. A candidate for this diploma must have satisfied the following requirements:—(1) he must be a member of the University; (2) he must have passed all the examinations required for the degree of B.A.; (3) he must have followed an approved course of study in scientific engineering and mining subjects, during two years; (4) he must have passed certain examinations in these subjects; (5) he must have undergone an approved course of practical training during four months in a mine. The time required for the course of study in subjects for the diploma is two years, but inasmuch as some of the examinations for the B.A. degree are either identical with those for the diploma, or may be substituted for them, one at least of these years may, by a proper choice of subjects, be counted during the course of the ordinary work for the degree, and the whole time of residence need not, therefore, exceed four years, even in the case where the whole diploma-course is taken at Oxford. A candidate may count, as part of his 2 years' work, a course or courses taken elsewhere than at Oxford, at institutions approved by the Home Secretary for the purposes of the Act, provided that they are approved by the University authorities.	Students must pass an entrance examination in June (previous to entry) in physics, chemistry and mathematics (equivalent to the standard attained by students in the preliminary year); or must attend the preliminary year and pass satisfactorily in all the subjects of instruction. No student is allowed to enter for the entrance examination, unless he has been educated in an institution recognized for this purpose by the Senate. The first and second years are spent thus:—Two days per week at the college, and the rest of the week at a colliery; the third year is spent wholly at the college. In order to obtain a diploma, students must— 1. Pass the sessional examinations in the subjects contained in the preliminary course. 2. Attend the course, and present themselves for examination in all the subjects of study in the first, second and third-year courses. 3. Obtain such a standard of marks as will satisfy the Senate that they are qualified to receive a diploma. 4. Produce evidence that, during the time which is not occupied at the college, they have received such practical colliery training as will satisfy the Senate, on the recommendation of the coal-mining committee, that they are properly qualified in this respect.

NAL INSTITUTIONS APPROVED BY THE HOME SECRETARY.—*Continued.*

SITY COLLEGE OF UTH WALES. nts are required an examination glish, arithmetic ebra. ler to obtain the , which will en- n to claim exemp- der the Act, the te must show that not had less than hs' practical ex- e in mines before g upon, or during, se of study. This inct from the 3 experience in a pecified by the d is to ensure that lent shall be in a t to profit by the lectures. This 4 ' experience may ed in either coal- al-mines, and in vacations or ise, provided that npleted before the he college course.	WIGAN MINING AND TECHNICAL COLLEGE. Students for the diploma course are required to pass an entrance examination in :— 1. English, including grammar, composition, and the geography of the British Empire. 2. Mathematics, including arithmetic ; algebra to quadratic equations; geometry, Euclid, books i.-iv., or their equivalent. 3. Freehand drawing. 4. General elementary science, including physics, chemistry and mechanics. 5. French, or German, or Latin. The course extends over 4 years :—Preliminary, first, second and third year. During the summer months in each of the preliminary, first and second years, students must spend a period of at least 4 months in a mine, or in an engineering (electrical or mechanical) workshop, under conditions to be afterwards arranged. At the close of the third year there is a special course in surveying.	

ROYAL SCHOOL OF MINES, LONDON.—*Continued.*

h student must keep a diary, stating how he had been employed, and ake careful notes and sketches while engaged in this practical work. nust be handed to the instructor in mine-surveying in the first fortnight ber in each year ; and the diary must be counter-signed by the managers mines at which the student has worked. Diary-forms must be obtained ie registrar or from the instructor in mine-surveying before the vacation. may be awarded for the note-books.

st-year students must attend some advisory lectures in mining, mineralogy ology, before leaving for the summer vacation.

student can pass in mining who has not qualified in assaying, in surveyd in metallurgy, part i.

ry candidate for the associateship of mining must obtain the certificate St. John Ambulance Association.

With reference to any criticism upon the course of lectures l laboratory work, etc., adopted at Birmingham, we, in itain, have hardly yet made up our minds even upon the bject of elementary education; secondary education is still in fluid condition; technical education, which must necessarily ome last, is naturally in a state of chaos; and teachers of mining, herefore, have not very much to guide them in drawing up a course of instruction. He (Mr. Merivale) thought that if any fault could be found with Prof. Redmayne's syllabus for mining engineers, that is, for those who were prepared to devote 3 years at least to a University training, it was, that it was too practical in its early stages. The time devoted to mining, section (*d*), during the first and second years would, in his opinion, he better spent in the study of modern languages. The student would have made a fair acquaintance with the grammar of at least one European language, besides his own, at school; and during his first and second years at college he should perfect himself therein, so that he might be able to read, write and speak it well enough for practical purposes. So many valuable mining books and papers are published in other modern languages besides English that the mining engineer, who is acquainted with none of them, cannot keep abreast of the times; not to mention the advantage of a knowledge of modern languages when visiting mines in other countries, for the purpose of studying foreign conditions and methods of working. He (Mr. Merivale) was of opinion that a student, capable of profiting by a 3 years' science course (spending his vacations in practical mining, and reading a few good elementary text-books), would make more progress in this way, and lay a better foundation for future success, than he would do if he spent any portion of his time in attending lectures on elementary mining. It was not until his third year that he should attend lectures on mining and on general engineering; and these should be of an advanced character, only within the grasp of a student who had already passed successfully through a course, 2 years at least, of pure science.

He (Mr. Merivale) considered that the courses suggested for the lower classes of students were excellent, and calculated to raise the standard of our managers and colliery officials.

Mr. William Galloway (Cardiff) wrote that, while readi

Prof. Redmayne's paper, the words "Columbia University" occurred to him more than once before he arrived at the reference to that institution. He (Mr. Galloway) had had the pleasure of calling upon Prof. H. S. Munroe in May last, and of seeing his splendid collection of mining machinery. It included a full-sized locomotive-engine with its driving wheels resting upon other wheels, by means of which the students are enabled to conduct practical tests, using either compressed air or steam, in much the same way as tests are made with a locomotive running upon a railway. On that occasion, he made a mental note of the outlay that must have been incurred for the instruction of the students in this department alone. He had done the same thing a few years previously in the mineral museum of the *Gorni Institut* (Mining School) of St. Petersburg, where he saw among numerous specimens of almost priceless gems, and great masses of gold, platinum, silver, copper, malachite, azurite, etc., four or five pearls valued at £7,000. On both occasions, he thought with regret of the comparatively meagre provision made for students of mining in this country. Prof. Redmayne, however, appeared to be more than usually well-supplied with funds for equipping his laboratories.

On reading his description of what he intended to do, it occurred to him (Mr. Galloway) that he was perhaps following the lead of Columbia University too closely, in preparing on a comparatively lavish scale for teaching metal-mining and leaving coal-mining somewhat in the background. The metal-miner works for the most part in what the coal-miner calls faults: the coal-miner works in what the metal-miner calls country or country-rock. Their methods are practically the same, but modified to suit the peculiar circumstances of each case. Again, in preparing their products for the market (including smelting-works under that term) the same class of apparatus is employed by both up to a certain point; the one recovers the lighter, the other the heavier mineral; the former rejects the heavier, the latter the lighter, as refuse. A liberal education in coal-mining teaches the metal-miner much that he ought to know, and similarly there are many things taught in metal-mining by which the coal-miner can profit. At the same time, there are (at any rate, in the more advanced stages) sufficient differences between the methods of working and preparation of the respective minerals, to justify a separate and distinct

course of study for each. Now, as this is a great coal-mining country and a comparatively very poor metal-mining one; and as some of the coal-fields are, metaphorically speaking, starving for want of men educated in their profession, while the metal-mining districts are supplied to overflowing, one would have thought that coal-mining would have the greater claim upon the University of Birmingham and metal-mining only an insignificant one, if any at all. Besides, most of the students trained in metal-mining in this country have to seek employment in the colonies and abroad. Why, then, should Birmingham add to their number, rather than endeavour to divert the eligible men to the coal-fields and keep them at home? Holding these views, he (Mr. Galloway) would have preferred to see the available funds of the Mining Department of the University of Birmingham spent in the purchase of coal-cleaning appliances, screens of various sorts, picking-bands, elevators, coal-jigs, models of the most approved coke-ovens (partly arranged for using the gases under steam-boilers, partly for the recovery of bye-products), briquette-making plant, tubbing, coffering, headgear, boring, sinking, ventilating, pumping and hauling appliances, etc., all of the most recent design and construction, rather than on an expensive working model for the mechanical preparation of ores.

He (Mr. Galloway) was aware that there is always a danger to be guarded against in collecting models lest those which have become antiquated should be preserved after they have served their purpose. The great collection of models of the *Gorni Institut* is a case in point. Probably about 90 per cent. of the models in that collection might be profitably relegated to a historical museum, or, perhaps better still, consigned to the flames. The student is not always capable of discerning between that which is efficient and modern and that which is inefficient and antiquated, and is, therefore, apt to pay as much attention to the latter as to the former. As a former student of the Freiberg Mining Academy, he (Mr. Galloway) could speak from personal experience on this point. A careful weeding out of whatever has been superseded or improved upon should be undertaken from time to time, and when this precaution is adopted, a collection of models may become an invaluable adjunct to the other means of imparting useful knowledge. Many of these models may, of course, be the actual machines

or tools themselves, and may be made to work in the laboratory in exactly the same way as in or about a mine.

There is no reason why coal-mining and metal-mining should not be taught side by side in the same school. On the contrary, it tends to enlarge the view and open the mind of each class of student to become acquainted with the methods of the other. But, as he had already remarked, this being essentially a coal-mining country and Birmingham being a great coal-mining centre, it would appear more natural to organize the Mining Department of the University of Birmingham more in accordance with those of the nearly pure coal-mining schools of Bochum, Mons, Liége, St. Etienne, etc., rather than with those which give a more prominent position to metal-mining. In saying this much, he was prepared to be told that Prof. Redmayne was keeping coal-mining well in view, and he felt that he might, therefore, be pleading with unnecessary persistence on behalf of the predominant claims of that great industry.

Mr. JAMES S. DIXON (Bothwell) wrote that the arrangements for teaching mining at the University of Birmingham seemed to be very complete. The experimental mine was, he imagined, unique, and must be of great advantage to the teachers and taught, from being so accessible at all times.

Till recently, in Scotland, young men learning to be mining engineers generally entered the offices of a firm practising that profession, where they acted as underground surveyors and draughtsmen as well, getting some experience of surface surveying, levelling and laying out works. There was no systematic teaching; but a clever and enquiring youth could pick up much information, and get a good knowledge of how the various kinds of underground works were conducted. He had, however, to acquire scientific knowledge relating to his work elsewhere, and during his apprenticeship got no, or little, experience in the actual handling of men and carrying-out of works.

Since the inauguration of the mining lectureship at Glasgow University, he (Mr. Dixon) had got some of the students into collieries during the 6 months' summer vacation, where, under the charge of the officials, they had had constant practical experience among the men and the work that was being carried on. It appeared to him that this plan of combining scientific and practical work was a good one, and should train up a set of

men eminently fitted to take command in the mines of the country. From his recollection of his own early days, this was the training of which he most felt the want, having been brought up on the system first described. He had to acquire scientific and practical knowledge by a longer and far more laborious process.

He was certain that the Mining Department of the University of Birmingham would prove an immense blessing and advantage to the rising generation of mining engineers of that district.

Prof. J. O. Arnold (University College, Sheffield) wrote that he had read Prof. Redmayne's able paper with the greatest interest. It was to him, and no doubt to all genuinely interested in raising the status and efficiency of British technologists, a source of satisfaction to see in the curriculum of a British University an inclusion of the use of practical plant as a matter of course. Therefore his remarks were offered, not in any spirit of captious criticism, but rather with all due deference, to lay before Prof. Redmayne and the members of The Institution of Mining Engineers the results of 15 years' experience obtained in Sheffield, the pioneer city in the matter of equipping its College with practical plant for the teaching of scientific metallurgy.

Broadly speaking, it appeared that Prof. Redmayne proposed to devote the first and second years of the 3 years' course mainly to the grounding of students in pure science: the third year being devoted to the practical application of the scientific knowledge so acquired "to engineering: mining, mechanical, civil, electrical and metallurgical." Was Prof. Redmayne really so sanguine as to anticipate that the most brilliant student could assimilate in his third year's applied course, anything more than a mere smattering of the five huge subjects dealt with? In Sheffield, starting with day students having an elementary knowledge of chemistry, physics and mathematics, the whole of the 3 years' course was devoted to the study of the metallurgy of a single metal, and this time was found sufficient only in the cases of very brilliant students.

With reference to the plant detailed in Prof. Redmayne's paper, it would no doubt be found distinctly useful, but it seemed to be on too small a scale to give really efficient instruction. The working plant for teaching the metallurgy of steel at the

Sheffield College (which, after working 12 years, was dismantled 3 years ago) was on a much larger scale than the mining plant at the University of Birmingham. Yet, although capable of doing good work, experience proved it to be too small, and hence at a cost of £12,000 it had been replaced by appliances about four times as large. It appeared that the whole of the plant in Prof. Redmayne's large laboratory, which he described as the largest individual laboratory of its kind in the world, could be worked by motors developing in the aggregate only about 20 horsepower. To work only one of the metallurgical laboratories of the Sheffield College it had been necessary to instal a battery of motors developing a total of no less than 150 horsepower.

But from an educational point of view, the most fatal deficiency in the University of Birmingham scheme was one for which at present Prof. Redmayne was in no way responsible. In its exclusion of evening students, the University of Birmingham technological scheme was fundamentally unsound. Industrial officers, comprizing managers, chemists and foremen, employed in the vast industries of the city and the large district within its sphere of influence, were deliberately debarred from the educational privileges of the University unless they threw up their posts for 3 years, a proceeding, in the great majority of cases, obviously impossible.

Also, in company with their superiors, intelligent workmen, earnestly desirous to qualify themselves scientifically to become officers in the industrial army of Birmingham, found the doors of its University shut upon them. How cold was educational reality compared with the glowing idealism of the platform!

Unless there was something fundamentally different in the industrial conditions obtaining in the Midlands from those existing in South Yorkshire, the following statistics would show how very grave was the educational error of the Senate of the University of Birmingham in excluding evening students. In the metallurgical department of the Sheffield College there were both day and evening sessions. In these, the courses were nearly identical, both day and evening students being eligible for the associateship in metallurgy, an examination about equivalent in severity to the average University degree of bachelor of science in honours. The only distinction made was that the day course extended over a minimum of 3 years, whilst the

evening course had a duration of either 4 or 5 years; whether 4 or 5 was decided by the result of a brief *viva voce* examination into the student's knowledge of elementary science. The stock University argument against evening students was that, owing to the fact that they were forced to win their bread during the day-time, they were too weary to assimilate scientific knowledge in the evening. From a theoretical point of view this argument seemed sound, but, like many other unassailable theoretical arguments, it had, in Sheffield, to a considerable extent broken down in practice. Table IV. embodied the relative proportion of those day and evening students who had won the blue ribbon of the metallurgical department from 1893 to 1904.

TABLE IV.—UNIVERSITY COLLEGE, SHEFFIELD.

Year.	Number of Day Students passing the Associateship Examination.	Number of Evening Students passing the Associateship Examination.	Year.	Number of Day Students passing the Associateship Examination.	Number of Evening Students passing the Associateship Examination.
1893	1	2	1900	4	0
1894	2	0	1901	3	0
1895	2	1	1902	0	3
1896	1	0	1903	2	0
1897	0	4	1904	2	2
1898	2	0			
1899	0	3	Totals	19	15

With reference to numbers, the following statistics of the metallurgical department of the Sheffield College impressively illustrated the necessity of honours courses in the evening. There were at present attending the practical courses (exclusive of the lecture courses) the following students, the evening department being full to overflowing:—Day students taking the full 3 years' course, 13; day students taking a portion of the full 3 years' course, 12; evening students taking the full 4 or 5 years' course, 163; evening students taking a portion of the course, 5; post-graduate students, formerly attending day or evening courses, 4; a total of 197 students. The post-graduate students were at present obliged to put up with worse accommodation than that provided for the ordinary student, hence their number was small; but before the end of the present session it would be at least trebled, because a specially roomy post-graduate laboratory, capable of accommodating twelve students, was being equipped. This laboratory would specially be filled by post-graduate students (managers and chemists in

local works) who desired to specialize in the higher branches of steel metallurgy. It was by no means contended that the foregoing metallurgical data formed an exact parallel to mining work, but it was respectfully urged that they constituted an approximate guide to the needs of a great industrial centre in connection with any branch of applied science.

In conclusion, there was one point upon which he (Prof. Arnold) felt compelled to differ considerably from Prof. Redmayne. The latter said that his course would not trespass upon the field of the county-council mining lecturer; but in this Prof. Redmayne was obviously mistaken. He also said that students, after preliminary training by such lecturers, would constitute a very desirable class of University students. No doubt, but unless the students of the Midland counties attending evening county-council lectures were very different from those of the Yorkshire coal-fields, they would be nearly all bread-winners, little likely to throw up their situations in order to attend a 3 years' University course. Indeed, the only exceptions would be perhaps two or three students who had succeeded in winning county-council scholarships of considerable annual value. The palpable ability of Prof. Redmayne's career and the fact that he himself had "been through the mill" seemed to constitute guarantees that he would eventually establish his department in the University of the midland metropolis on a sound basis, unless indeed it was overshadowed by the great laboratory of metalliferous mining which seemed likely to be established in London under Government auspices. It might, however, well be that in this connection there was room for both London and Birmingham to train those urgently-needed mining metallurgists of British origin, whose duty it would be to command the mines of Britain's colonies. But before Prof. Redmayne could claim like him (Prof. Arnold) to have had 15 years' stern experience in a great industrial centre, was destined to endure anxious moments while steering his ship through the troubled waters of British educational biology.

R. Mullineux Walmsley (Northampton Institute, London) wrote that the interest of Prof. Redmayne's paper was not confined to those who were engaged in the education of mining engineers only, but appeared to extend to all who were engaged in

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Dr. R. Mullineux Walmsley (Northampton Institute, London) wrote that the interest of Prof. Redmayne's paper was not confined to those who were engaged in the education of mining engineers only, but appeared to extend to all who were engaged in

engineering education, since the training described was based upon principles which should be generally applicable.

The "complete or degree mining course," comprizing, as it did, mathematical, general, pure and applied science and specific mining instruction extending over 3 years, appeared to include most of the subjects likely to be required by a fully trained mining engineer, but the absence of time-tables, or summaries of time-tables, showing how much time was allotted to each subject scheduled, made it impossible to judge whether all the subjects could be adequately studied in the period named. A perusal of what was included in the purely mining section of each year pointed to the conclusion that, unless the students started with a very fair knowledge of mathematics and the pure science subjects referred to, the time available at the University would only, in some of these subjects, lead up to that half-knowledge which was worse than useless in practical life. The list of subjects in the third year was somewhat alarming, and it was to be hoped that the mistake made by the engineering departments of many American Universities would be avoided, namely, the introduction into the last year of the undergraduate's course of a crowd of professional subjects utterly beyond the powers of any student to assimilate usefully in the time.

It was stated that courses of instruction had been arranged to meet the requirements of various classes of students, such as "mining engineers," "colliery managers," "mine-surveyors" and others. Amongst these, but placed in a class by themselves, were "teachers of mining, such as county-council lecturers, and lecturers in technical colleges." The natural inference was that, in the opinion of the University authorities, teachers of mining could be adequately trained within the walls of the University, and without having any professional or commercial experience of mining work. Surely, this was a retrograde step. The county-council lecturer belonged to a class with which he (Dr. Walmsley) had not come much into contact, but certainly the lecturers in technical colleges should not be men whose training had been entirely collegiate. It was, without doubt, essential that they should have had college training, to ensure that they would deal with their subject from a wide point of view; but, in addition, they as certainly required to have that further training by contact with the realities of the profession which no college could give, however well equipped with machinery or experi-

ental mines, etc. The visits to mines and the summer courses ›re obviously intended partly to meet this difficulty; but ›wever admirable and necessary in themselves, they were not, d never could be, the equivalent of the rough-and-tumble perience of real professional and practical work.

In view of the large amount of work to be faced, it was a wise ›p to relegate all real research and post-graduate work to a ırth year; but as this point had probably been dwelt upon the speakers in the discussion, he (Dr. Walmsley) refrained ›m enlarging upon it.

Mr. J. T. Beard (Scranton, Pa., U.S.A.) wrote that it was ghly gratifying to note the steady and rapid increase in the tention that was being given to the training of men in the rious callings and trades in which they were daily employed. ıis was true at the present time, both in Great Britain and in the ıited States. Formerly a college training was by common nsent considered as adapted only to those who intended to llow a professional life. Skilled mechanics or artisans were e sole product of the shop, having received their training as prentices. The result was a deplorable lack of knowledge of eory and principles on the part of these men, who necessarily, a class, were prone to hold prejudiced views in favour of their n ways and methods of doing different kinds of work. This ndition was not at all suggestive of the spirit of the times in ıich we are now living, which spirit recognizes the importance the education as well as the training of the workman. Know-lge is what is required, and the interesting description by of. Redmayne, in his paper, of the provision made for meeting e needs of the several classes of students who will attend the niversity of Birmingham, has proved that that institution is ›reast of the times.

In America, and doubtless in Great Britain and on the ›ntinent also, much is being done to place technical education ithin the reach of those who are employed during the day at eir various occupations. Night schools are held in all the large ties, and in many instances these schools are free to all who ›sire to avail themselves of the opportunities which they offer. ree lectures are given under the auspices of the different societies ıd engineering organizations. In many smaller towns and manu-ıcturing districts it is common for large corporations, employing

any persons, to establish and maintain for the sole benefit of their employés, and at an expense of several thousands of pounds annually, extensive sociological departments, often erecting large buildings, club-rooms and lecture-halls in the carrying out of this purpose. Companies often arrange courses of free lectures, employing able lecturers to speak on various technical subjects, for the sole purpose of fostering a desire for knowledge on the part of their employés, who are daily in charge of expensive machinery and costly operations.

Reference is made to this work undertaken by the University as not trespassing on the field covered by the mining lecturers appointed by county councils. This is not, however, a question of trespass; the work of the college always stands first. As an educational institution, the college has pre-eminently the first right to be considered. Its field is a different field from that covered by county-council lecturers, but if any conflict occurs, the work of the lecturer must be considered as subordinate to that of the college. The lecturer creates a desire or thirst for knowledge, which it is the function of a college to supply. One class of men reached by a lecturer are the curious, who have no desire to enter upon a regular course of study such as would be required in a college, but are anxious to pick up titbits of information that will assist them in various ways in their several occupations. Another class are those who have had no early schooling, and who now feel the need of more knowledge than they possess, but whose circumstances will not permit them to attend a college. It is the province of a lecturer to awaken a deeper interest in the minds of the curious, and to create in such a thirst for knowledge that will lead them, in many cases, to seek a college education.

After an experience of 13 years in giving correspondence instruction to all classes of men interested in mining, and knowing the great value of this method of instruction to all classes of men, he would not for a moment be understood as recommending a correspondence course of instruction in preference to a college course. The same is true likewise of the night schools; all these sources of education supply a great need, but none of them can be understood as in any sense competing with a college in the manner of imparting knowledge or the kind of instruction given. Although this was perhaps a larger view of educational

matters than some would be prepared to take, he thought, however, that it would be pretty generally conceded to be correct. All education is by right institutional; it must be rudimentary and thorough.

The college curriculum, as described by Prof. Redmayne, seemed admirably adapted to the needs of the several classes of students which it was intended to reach, and would undoubtedly do much to broaden the influence of the University. Much attention was wisely given to bringing the student into contact with the commercial and practical conditions affecting the problems which he was engaged in studying, the result of which must be of great benefit both to the professors in charge and to the students. The only suggestion that occurred to him was the possible introduction into the first year's study of sufficient drawing, to enable students to make a freehand sketch of simple machines or parts of machines needing repairs, and to draw readily an intelligent plan of any proposed work. The purpose of this would be to render more complete the practical training received by such irregular students who attend the first year only. A knowledge of freehand sketching is of the greatest practical importance to mining men in charge of any kind of mining work.

Mr. J. A. Longden (Stanton-by-Dale) wrote that Prof. Redmayne's paper on the Mining Department of the University of Birmingham opened a very wide question. As a member of the Examination Board for the Midland mines-inspection district, he might state that they had always considered 5 years at a mine to be most essential. Mining engineering is the most diversified in its operations of any of the professions. The laying-out of surface-works requires a good knowledge of all mechanical appliances, including electricity. The making of railways, the construction of bridges, the erection of shops and engine-houses, the design of engines, boilers, and tools of all kinds, the putting together of the best method of cleaning and sorting the coal, the building of headstocks, with all the details attached to the various branches, meant that a mining engineer must be an all-round man aboveground if he was to be successful. Then the varying conditions of opening-out a mine was a most important item, and lack of knowledge in this particular had ruined many a colliery for all time; not only must the inclination and the thickness of

the seam be taken into account, but also the liability to spontaneous combustion, and the contiguity of other workable seams, causing creeps and general disturbance of the roads and faces. Then the whole art of surveying must be thoroughly understood, and every branch of lawyers' work must be at the finger-ends of the mining engineer. He must also have a knowledge of the management of schools, and how best to promote the welfare of the men when away from work.

His (Mr. Longden's) contention had always been that, having a due regard to safety and economy, 5 years was not too much for a man to give to the requirements of all the knowledge necessary for the working of a mine; and as practical men were the only men that were of any use at a colliery, he did not consider 2 years at a mine sufficient, and 3 years, even although that had now been settled by Act of Parliament, was, in the opinion of many mining people, not enough. Much of the instruction which Prof. Redmayne suggested ought to be acquired by the pupil who intended to follow the profession of mining engineering before he actually started on his five years' course of instruction.

There was another question arising out of the subject, whether a man ought to be able to obtain a first-class certificate for management when he was 23 years of age. If conscription were in force in this country, that would put everything back 2 years, and for a man to have control over large bodies of men, besides the responsible position of spending large sums of money, the age of 25 was quite young enough.

The 4 months' holiday in the year usually given at Universities, in addition to 1 day a week at other times, constituted an amount of holiday that no other nation gave, and would have to be curtailed if they were to hold their own with Germans and Americans.

Mr. W. F. A. Thomas (London) wrote that, while admitting that there was room for improved technical education in mining and metallurgy, he was strongly of opinion that it was a mistake for any endeavour in this direction to take the shape of trying to give practical experience at a college, of taking up the student's time with manipulating machinery and playing, as it were, at practice, when every moment was needed for the acquisition and understanding of the theory, which [illegible] on which their subsequent [illegible]

built. To attempt to build up this practical experience at the expense of the solidity of the theoretical foundation (which must suffer) was to court failure. Students should realize that the only practical experience of value was to be obtained in actual practical works, after their college training was finished.

The equipment of American mining colleges was often pointed to as an example to emulate. He thought, however, that any superiority, fancied or real, of American mining engineers over British was not at all due to the equipment of their colleges with machinery, on a large scale, but to the nature of their environment, enabling them after their college career to step at once into the midst of bustling practice, and also perhaps to some extent to the practical knowledge and experience of the teaching staff, which was of far more importance than any elaborate collection of machinery, that was constantly being improved upon and superseded. The field of the various mining and metallurgical operations was so vast, that the practical experience which a student could gain at a college, even with very elaborate plant, could be only very one-sided. Why, then, attempt it at all? The necessarily large sums of money thus spent, would, in his opinion, be much more profitably employed in securing first-class practical instructors, giving them every facility to keep up to date and in close touch with practice, and confining the equipment of the college to accurate scale-models and apparatus for small laboratory tests only, as complete as possible.

The model coal-mine was certainly convenient to teach surveying where no mines were handy, but it was questionable whether the same object could not have been attained more efficiently and at far less cost by taking the students for a short time to a mine, and teaching them there under actual working conditions.

With the exception of what bore on the principle that he had wished to emphasize, that it was a waste of money to instal machinery or mines to reproduce actual working practice at a college, the University of Birmingham appeared to be well equipped [illegible] to utilize their time to the best [illegible] on [illegible]hers.

[illegible] wrote that he had [illegible]ag Department of [illegible]itham) having also

he past 2 years had the mapping out of a similar depart-
r the University of Glasgow, could fully understand and
iate the many difficulties with which Prof. Redmayne had
contend. He quite agreed that the ground covered by
niversity course in mining engineering should in no way
ap the very excellent work being carried out by the various
ty councils in all parts of the country, in this particular
ch of education. They should run jointly, hand in hand,
being made a feeding ground for the other. His own ex-
ience as a county-council lecturer, for over 12 years, had taught
m that it was quite impossible in such work to do more than just
uch on the higher branches; and, that in order to make the
struction complete, mining departments similar to that at Bir-
ningham and elsewhere had become an absolute necessity.

It was, he thought, impossible to lay down any hard-and-fast rule as to the curriculum that a student should follow, as so much depended on which branch of the mining profession it was his intention to follow, but whatever the curriculum might be, it was essential that it should be some combination of theory with practice. This, in the past, had often been met by a student attending classes held in the evening, after he had finished his work at the mine, or in the engineer's office. He (Mr. Latham) did not for one moment wish to underrate the value of such evening classes—they had done, and were still doing, splendid work in their own particular sphere—but he found, from experience, that a student coming from a hard day's practical work was scarcely in the best physical condition to do himself and his studies full justice. It was now more than ever necessary, in these days of rapid scientific advance in connection with engineering, that a student should have a thorough grounding in pure science, and he thought that such training should be given with a view to its application afterwards to practical work.

The course in Glasgow University virtually covered the same ground as that laid down by Prof. Redmayne at Birmingham, consisting of three full-year courses made up as follows:—First year: mathematics; natural philosophy; chemistry; chemical laboratory; and mining, class i. Second year: engineering, class i.; engineering, class ii. or iii.; surveying; drawing; geology and mineralogy; and mining, class ii. Third year: electrical engineering; metallurgy; metallurgical laboratory;

engineering laboratory; and mining, class iii. Students were required to matriculate for the degree of bachelor of science in mining engineering, but matriculation was not necessary for the certificate of proficiency granted in mining engineering, the curriculum for this latter being the same as for the degree, with that exception. In Glasgow they only ran a winter session from the end of September to the end of March, but the lecture-hours were somewhat longer than in England, being from 8 a.m. to 5 p.m. The summer was devoted wholly to practical work in the mines. Through the kindness of Mr. James S. Dixon, students were quartered at most of the leading collieries in Scotland, and were thus able to obtain practical knowledge without in any way being overworked, or allowing the two, theory and practice, to interfere the one with the other. Such an arrangement had always appeared to him to be the true solution of this difficult problem, and so far as they in Glasgow had gone they had every reason to be satisfied with the results obtained.

The experimental mine mentioned by Prof. Redmayne would, he (Mr. Latham) thought, be most useful, and he only wished that it were possible to adopt it in his own case, but this could not be done at present.

Mr. F. J. Rowan (Glasgow) wrote that the accommodation provided for the Mining Department at the University of Birmingham appeared to be on a generous scale. The equipment of the laboratories was excellent, with the exception of appliances for dealing with normal and abnormal quantities of water in mines, of which he did not see any notice. He thought that the idea of a small experimental mine was a good one, and it would be a great aid in conveying instruction in the elements of mine-surveying and ventilation. The scheme of instruction was also excellent, and left little to be desired in the case of the better class of students. But as all students were not cast in the same mould, he always felt that some flexibility was required in such courses. He was especially pleased with the provision of a grounding in pure science, because he had long held that it was the possession of such knowledge that marked the difference between the engineer and the mechanic in every branch of engineering. At the same time, it could not be denied that the capacity of some to grasp and profit by such knowledge was greater

than that of others, who, however, might be capable of a greater degree of skill in the details of practical operations. On this account, it appeared to him that if a scheme of instruction was to suit both classes of students, so that both might derive the greatest benefit from it, it should provide for some alternative distribution of subjects by which some students could devote more time to the pure than to the applied science, while others could reverse that process. The completeness of Prof. Redmayne's course, as a whole, was beyond question, and engineers who were devoted to the mining branch of their profession had reason to be congratulated on the establishment of such a perfectly devised school of instruction as that of the Mining Department of the University of Birmingham.

Mr. T. C. Futers (Broomhill Colliery) wrote that whilst the courses of instruction were arranged so that one might take a special course in any of the different branches of mining engineering, yet there appeared to be no provision for the training of mechanical engineers of collieries. Perhaps this was a difficult and delicate question to raise, as under the Coal-mines Regulation Act the certificated colliery manager was obliged to become acquainted with mechanical and electrical engineering. Considering, however, the growing importance of mechanical and electrical machinery in and about mines, he ventured to ask: Was it fair to expect a colliery manager to have that thorough knowledge of the working and winning of large areas of coal, entailing a study of geology, ventilation, methods of working coal, surveying and, to some extent, chemistry, and, at the same time, to have such a knowledge of mechanical and electrical engineering (each in themselves separate professions) as to be able to design and instal boilers, engines, dynamos, winding, hauling, pumping and screening machinery, etc., and to undertake full responsibility for the efficient and safe working of the same? Under present conditions, the mechanical engineer of a colliery had no status, and consequently young men who would otherwise probably prefer a mechanical and electrical training had, in order to secure a "position," to become a colliery manager instead of a colliery engineer. He ventured to suggest that it would be in the interests of mining engineering if a special course of training in the

ıechanical and electrical engineering of collieries could be stablished, and students specially educated for this branch; ıis, however, would be useless unless colliery-owners were prearedto recognize colliery mechanical engineering as a proession and give to those trained in it the responsibility and tatus due to the position. A step in the right direction had een taken in the North of England, where courses of instruction or colliery engineers were established at the Armstrong College.

Prof. ROBERT H. RICHARDS (Massachusetts Institute of Techology, Boston, Mass., U.S.A.) wrote that he had been much nterested in the paper by Prof. R. A. S. Redmayne upon the ining school of the University of Birmingham; and it showed hat the school was making good progress under wise manageıent. In reading the paper, his attention was naturally drawn o the methods, which differed from those used at the Massahusetts Institute of Technology, with which he was associated. 'he experimental coal-mine, covering an area of $\frac{3}{4}$ acre, seemed nnecessary, as timbering, haulage, ventilation and surveying an all be taught in the summer school at the mines; and some f them better taught than in an experimental mine. He (Prof. ichards) thought that Prof. H. S. Munroe's method of running ıll-sized concentrating jigs and tables, had been adopted, taking ınning samples of the feed and the various products, as would ave to be done in a large mill for testing the run. He (Prof. ichards) had adopted the method of using machines of much educed size, and catching, weighing, sampling and assaying all ıe products made. He found that it afforded a very perfect ccount of the stock and was well adapted to the age of the udents taught. This method was well adapted to the investiations made in graduating theses. It was a simple matter to xplain the running sampling of the mill after students had one this work. The size of the apparatus, with the distance om the ore-supplies, seemed to indicate that a portion of the pparatus would be simply models to be looked at, rather than pparatus with which to do work, take for example, the amalgaıating pans, 3 feet in diameter. The cost of bringing ore would e prohibitive. In his laboratory, there were ten pans, 7 inches ı diameter; they were supplied from a parcel of 1 ton of Mexican re, which was a supply for ten years. Every student had an

opportunity of actually performing this experiment under varying conditions at trifling expense, and the apparatus was so perfect that results equal to the best mill-practice were obtained. The provision of a museum, well-equipped with fine models of mechanism and mine-machinery which students walked by every day, must have great influence for good, in familiarizing them with good practice. The insertion of lectures on mining, very early in the course, must be of great benefit in awakening the interest in professional things at an early stage, supplying the students with the zeal needed to carry them over the less attractive non-professional work: this was a plan that other schools would do well to copy.

Mr. L. T. O'Shea (Sheffield) wrote that he had read Prof. Redmayne's paper with much interest, and had no doubt that it would receive considerable attention from all responsible for mining education, since it appeared at a time of considerable activity in that branch of technological instruction, caused, doubtless, by the foundation of local universities in industrial centres, and by the recognition of courses of studies in the qualifications for a first-class manager's certificate.

Prof. Redmayne had made a very comprehensive classification of those students for whom the mining department of a university should provide instruction, but he (Mr. O'Shea) was rather surprised to find that no provision was made for those who were unable to take advantage of the instruction given in day classes, and he ventured to think that, in ignoring evening and Saturday afternoon classes, Prof. Redmayne was missing a great opportunity for spreading the influence of the university amongst a most important class of the mining community. His reason for not providing evening classes was that this work was ably carried out under the scheme of the county council. In South Yorkshire and Derbyshire, a large amount of instruction in mining was carried on by means of county-council lectures, and of local classes in mining villages, and his (Mr. O'Shea's) experience was, that it was possible only, in a few exceptional cases, to provide for more than elementary instruction by these means; further, that there was a very considerable number of students trained in these classes who were desirous of pursuing their studies at an institution properly equipped for more

advanced instruction. These formed a very desirable class of students, industrious, painstaking, and enthusiastic men, who were anxious to rise in their calling, and hoped to do so by educating themselves under the best possible teachers. He ventured to say that it was the duty of a local university to encourage such students by opening its doors to them, not so much with the object of granting degrees, as because it was for the good of the industry that those men capable of rising from the lowest to the highest ranks in that industry should be afforded the opportunity of obtaining the very best education in their profession if they desired it. Prof. Redmayne had said that the more promising of these students would, doubtless, join the day classes. He (Mr. O'Shea) was inclined to think that he would be disappointed in this respect. These students were men who, by force of circumstances, were compelled to earn their living, and could not afford to pay the fees, or to spend even two or three days a week in attending day classes at a college. Only by the granting of valuable scholarships, which would enable a man not merely to pay his fees but also to live, was it possible, so far as he (Mr. O'Shea) could see, for these students to obtain any advantages from the university courses. It seemed to him (Mr. O'Shea) that under-managers and deputies were the backbone of the mining industry, and the more efficiently they were educated the better for that industry. By encouraging these men, the mining department of a university was using its influence to the very best advantage.

Perhaps Prof. Redmayne hoped to exert this influence through the teachers for whom the university is to provide instruction, but here again his (Mr. O'Shea's) experience was that evening and Saturday-afternoon classes were necessary, if all classes of teachers were to benefit. Teachers of mining might be classified as: (1) university professors and lecturers, (2) lecturers in technical schools, (3) county-council lecturers, and (4) teachers of local classes in mining villages. In his (Mr. O'Shea's) opinion, it was chiefly the last class that Prof. Redmayne would fail to reach, namely, the teachers who were responsible for laying the foundations of the education of a very large proportion of the mining population. This class of teachers was composed of (1) schoolmasters without any practical experience of mining, but who, by attending classes and passing the Board of Educa-

any persons, to establish and maintain for the sole benefit o
heir employés, and at an expense of several thousands of pound
nnually, extensive sociological departments, often erecting larg
buildings, club-rooms and lecture-halls in the carrying out o
this purpose. Companies often arrange courses of free lecture
employing able lecturers to speak on various technical subject
for the sole purpose of fostering a desire for knowledge on th
part of their employés, who are daily in charge of expensi
machinery and costly operations.

Reference is made to this work undertaken by the Universi ty as not trespassing on the field covered by the mining lectur rs appointed by county councils. This is not, however, a questi on of trespass; the work of the college always stands first. As an educational institution, the college has pre-eminently the fi st right to be considered. Its field is a different field from t at covered by county-council lecturers, but if any conflict occ rs, the work of the lecturer must be considered as subordinate to that of the college. The lecturer creates a desire or thirst for knowledge, which it is the function of a college to supply. One class of men reached by a lecturer are the curious, who have no desire to enter upon a regular course of study such as would be required in a college, but are anxious to pick up titbits of information that will assist them in various ways in their several occupations. Another class are those who have had no early schooling, and who now feel the need of more knowledge than they possess, but whose circumstances will not permit them to attend a college. It is the province of a lecturer to awaken a deeper interest in the minds of the curious, and to create in such a thirst for knowledge that will lead them, in many cases, to seek a college education.

After an experience of 13 years in giving correspondence instruction to all classes of men interested in mining, and knowing the great value of this method of instruction to all classes of men, he would not for a moment be understood as recommending a correspondence course of instruction in preference to a college course. The same is true likewise of the night schools; all these sources of education supply a great need, but none of them can be understood as in any sense competing with a college in the manner of imparting knowledge or the kind of instruction given. Although this was perhaps a larger view of educational

ıatters than some would be prepared to take, he thought, however, ıat it would be pretty generally conceded to be correct. All ducation is by right institutional; it must be rudimentary and ıorough.

The college curriculum, as described by Prof. Redmayne, ɜemed admirably adapted to the needs of the several classes of ıudents which it was intended to reach, and would undoubtedly ɔ much to broaden the influence of the University. Much atten- on was wisely given to bringing the student into contact with ıe commercial and practical conditions affecting the problems hich he was engaged in studying, the result of which must be f great benefit both to the professors in charge and to the ɜudents. The only suggestion that occurred to him was the ossible introduction into the first year's study of sufficient draw- ıg, to enable students to make a freehand sketch of simple ıachines or parts of machines needing repairs, and to draw eadily an intelligent plan of any proposed work. The purpose f this would be to render more complete the practical training eceived by such irregular students who attend the first year ınly. A knowledge of freehand sketching is of the greatest ɔractical importance to mining men in charge of any kind of nining work.

Mr. J. A. Longden (Stanton-by-Dale) wrote that Prof. Redmayne's paper on the Mining Department of the University ɔf Birmingham opened a very wide question. As a member of the Examination Board for the Midland mines-inspection district, he ınight state that they had always considered 5 years at a mine to ɔe most essential. Mining engineering is the most diversified in its operations of any of the professions. The laying-out of sur- face-works requires a good knowledge of all mechanical appli- ances, including electricity. The making of railways, the con- ɜtruction of bridges, the erection of shops and engine-houses, the design of engines, boilers, and tools of all kinds, the putting together of the best method of cleaning and sorting the coal, the building of headstocks, with all the details attached to the various branches, meant that a mining engineer must be an all-round man aboveground if he was to be successful. Then the varying conditions of opening-out a mine was a most important item, and lack of knowledge in this particular had ruined many a colliery for all time; not only must the inclination and the thickness of

the seam be taken into account, but also the liability to spontaneous combustion, and the contiguity of other workable seams, causing creeps and general disturbance of the roads and faces. Then the whole art of surveying must be thoroughly understood, and every branch of lawyers' work must be at the finger-ends of the mining engineer. He must also have a knowledge of the management of schools, and how best to promote the welfare of the men when away from work.

His (Mr. Longden's) contention had always been that, having a due regard to safety and economy, 5 years was not too much for a man to give to the requirements of all the knowledge necessary for the working of a mine; and as practical men were the only men that were of any use at a colliery, he did not consider 2 years at a mine sufficient, and 3 years, even although that had now been settled by Act of Parliament, was, in the opinion of many mining people, not enough. Much of the instruction which Prof. Redmayne suggested ought to be acquired by the pupil who intended to follow the profession of mining engineering before he actually started on his five years' course of instruction.

There was another question arising out of the subject, whether a man ought to be able to obtain a first-class certificate for management when he was 23 years of age. If conscription were in force in this country, that would put everything back 2 years, and for a man to have control over large bodies of men, besides the responsible position of spending large sums of money, the age of 25 was quite young enough.

The 4 months' holiday in the year usually given at Universities, in addition to 1 day a week at other times, constituted an amount of holiday that no other nation gave, and would have to be curtailed if they were to hold their own with Germans and Americans.

Mr. W. F. A. Thomae (London) wrote that, while admitting that there was room for improved technical education in mining and metallurgy, he was strongly of opinion that it was a mistake for any endeavour in this direction to take the shape of trying to give practical experience at a college, of taking up the student's time with manipulating machinery and playing, as it were, with practice, when every moment was needed for the thorough study and understanding of the theory, which was the solid foundation on which their subsequent practical experience could be useful.

built. To attempt to build up this practical experience at the expense of the solidity of the theoretical foundation (which must suffer) was to court failure. Students should realize that the only practical experience of value was to be obtained in actual practical works, after their college training was finished.

The equipment of American mining colleges was often pointed to as an example to emulate. He thought, however, that any superiority, fancied or real, of American mining engineers over British was not at all due to the equipment of their colleges with machinery, on a large scale, but to the nature of their environment, enabling them after their college career to step at once into the midst of bustling practice, and also perhaps to some extent to the practical knowledge and experience of the teaching staff, which was of far more importance than any elaborate collection of machinery, that was constantly being improved upon and superseded. The field of the various mining and metallurgical operations was so vast, that the practical experience which a student could gain at a college, even with very elaborate plant, could be only very one-sided. Why, then, attempt it at all? The necessarily large sums of money thus spent, would, in his opinion, be much more profitably employed in securing first-class practical instructors, giving them every facility to keep up to date and in close touch with practice, and confining the equipment of the college to accurate scale-models and apparatus for small laboratory tests only, as complete as possible.

The model coal-mine was certainly convenient to teach surveying where no mines were handy, but it was questionable whether the same object could not have been attained more efficiently and at far less cost by taking the students for a short time to a mine, and teaching them there under actual working conditions.

With the exception of what bore on the principle that he had wished to emphasize, that it was a waste of money to instal machinery or mines to reproduce actual working practice at a college, the University of Birmingham appeared to be well equipped to enable students to utilize their time to the best advantage; and the rest depended on the teachers.

Mr. Charles Latham (Glasgow University) wrote that he had read with pleasure the description of the Mining Department of the University of Birmingham, and he (Mr. Latham) having also

the past 2 years had the mapping out of a similar depart-
for the University of Glasgow, could fully understand and
eciate the many difficulties with which Prof. Redmayne had
to contend. He quite agreed that the ground covered by
university course in mining engineering should in no way
erlap the very excellent work being carried out by the various
unty councils in all parts of the country, in this particular
ranch of education. They should run jointly, hand in hand,
one being made a feeding ground for the other. His own ex-
perience as a county-council lecturer, for over 12 years, had taught
him that it was quite impossible in such work to do more than just
touch on the higher branches; and, that in order to make the
instruction complete, mining departments similar to that at Bir-
mingham and elsewhere had become an absolute necessity.

It was, he thought, impossible to lay down any hard-and-fast
rule as to the curriculum that a student should follow, as so
much depended on which branch of the mining profession it was
his intention to follow, but whatever the curriculum might be, it
was essential that it should be some combination of theory with
practice. This, in the past, had often been met by a student
attending classes held in the evening, after he had finished his
work at the mine, or in the engineer's office. He (Mr. Latham)
did not for one moment wish to underrate the value of such
evening classes—they had done, and were still doing, splendid
work in their own particular sphere—but he found, from experi-
ence, that a student coming from a hard day's practical work wa
scarcely in the best physical condition to do himself and hi
studies full justice. It was now more than ever necessary, in thes
days of rapid scientific advance in connection with engineering
that a student should have a thorough grounding in pure science
and he thought that such training should be given with a view t
its application afterwards to practical work.

The course in Glasgow University virtually covered the sam
ground as that laid down by Prof. Redmayne at Birmingha
consisting of three full-year courses made up as follows:—Fir
year: mathematics; natural philosophy; chemistry; chemic
laboratory; and mining, class i. Second year: engineerin
class i.; engineering, class ii. or iii.; surveying; drawin
geology and mineralogy; and mining, class ii. Third year: el
trical engineering; metallurgy; metallurgical laborato

engineering laboratory; and mining, class iii. Students were required to matriculate for the degree of bachelor of science in mining engineering, but matriculation was not necessary for the certificate of proficiency granted in mining engineering, the curriculum for this latter being the same as for the degree, with that exception. In Glasgow they only ran a winter session from the end of September to the end of March, but the lecture-hours were somewhat longer than in England, being from 8 a.m. to 5 p.m. The summer was devoted wholly to practical work in the mines. Through the kindness of Mr. James S. Dixon, students were quartered at most of the leading collieries in Scotland, and were thus able to obtain practical knowledge without in any way being overworked, or allowing the two, theory and practice, to interfere the one with the other. Such an arrangement had always appeared to him to be the true solution of this difficult problem, and so far as they in Glasgow had gone they had every reason to be satisfied with the results obtained.

The experimental mine mentioned by Prof. Redmayne would, he (Mr. Latham) thought, be most useful, and he only wished that it were possible to adopt it in his own case, but this could not be done at present.

Mr. F. J. Rowan (Glasgow) wrote that the accommodation provided for the Mining Department at the University of Birmingham appeared to be on a generous scale. The equipment of the laboratories was excellent, with the exception of appliances for dealing with normal and abnormal quantities of water in mines, of which he did not see any notice. He thought that the idea of a small experimental mine was a good one, and it would be a great aid in conveying instruction in the elements of mine-surveying and ventilation. The scheme of instruction was also excellent, and left little to be desired in the case of the better class of students. But as all students were not cast in the same mould, he always felt that some flexibility was required in such courses. He was especially pleased with the provision of a grounding in pure science, because he had long held that it was the possession of such knowledge that marked the difference between the engineer and the mechanic in every branch of engineering. At the same time, it could not be denied that the capacity of some to grasp and profit by such knowledge was greater

than that of others, who, however, might be capable of a greater degree of skill in the details of practical operations. On this account, it appeared to him that if a scheme of instruction was to suit both classes of students, so that both might derive the greatest benefit from it, it should provide for some alternative distribution of subjects by which some students could devote more time to the pure than to the applied science, while others could reverse that process. The completeness of Prof. Redmayne's course, as a whole, was beyond question, and engineers who were devoted to the mining branch of their profession had reason to be congratulated on the establishment of such a perfectly devised school of instruction as that of the Mining Department of the University of Birmingham.

Mr. T. C. Futers (Broomhill Colliery) wrote that whilst the courses of instruction were arranged so that one might take a special course in any of the different branches of mining engineering, yet there appeared to be no provision for the training of mechanical engineers of collieries. Perhaps this was a difficult and delicate question to raise, as under the Coal-mines Regulation Act the certificated colliery manager was obliged to become acquainted with mechanical and electrical engineering. Considering, however, the growing importance of mechanical and electrical machinery in and about mines, he ventured to ask: Was it fair to expect a colliery manager to have that thorough knowledge of the working and winning of large areas of coal, entailing a study of geology, ventilation methods of working coal, surveying and, to some extent chemistry, and, at the same time, to have such a knowledge of mechanical and electrical engineering (each in themselves separate professions) as to be able to design and instal boilers, engines, dynamos, winding, hauling, pumping and screening machinery, etc., and to undertake full responsibility for the efficient and safe working of the same? Under present conditions, the mechanical engineer of a colliery had no status and consequently young men who would otherwise probably prefer a mechanical and electrical training had, in order to secure a "position," to become a colliery manager instead of a colliery engineer. He ventured to suggest that it would be in the interests of mining engineering if a special course of training in the

mechanical and electrical engineering of collieries could be established, and students specially educated for this branch; this, however, would be useless unless colliery-owners were prepared to recognize colliery mechanical engineering as a profession and give to those trained in it the responsibility and status due to the position. A step in the right direction had been taken in the North of England, where courses of instruction for colliery engineers were established at the Armstrong College.

Prof. ROBERT H. RICHARDS (Massachusetts Institute of Technology, Boston, Mass., U.S.A.) wrote that he had been much interested in the paper by Prof. R. A. S. Redmayne upon the mining school of the University of Birmingham; and it showed that the school was making good progress under wise management. In reading the paper, his attention was naturally drawn to the methods, which differed from those used at the Massachusetts Institute of Technology, with which he was associated. The experimental coal-mine, covering an area of $\frac{3}{4}$ acre, seemed unnecessary, as timbering, haulage, ventilation and surveying can all be taught in the summer school at the mines; and some of them better taught than in an experimental mine. He (Prof. Richards) thought that Prof. H. S. Munroe's method of running full-sized concentrating jigs and tables, had been adopted, taking running samples of the feed and the various products, as would have to be done in a large mill for testing the run. He (Prof. Richards) had adopted the method of using machines of much reduced size, and catching, weighing, sampling and assaying all the products made. He found that it afforded a very perfect account of the stock and was well adapted to the age of the students taught. This method was well adapted to the investigations made in graduating theses. It was a simple matter to explain the running sampling of the mill after students had done this work. The size of the apparatus, with the distance from the ore-supplies, seemed to indicate that a portion of the apparatus would be simply models to be looked at, rather than apparatus with which to do work, take for example, the amalgamating pans, 3 feet in diameter. The cost of bringing ore would be prohibitive. In his laboratory, there were ten pans, 7 inches in diameter; they were supplied from a parcel of 1 ton of Mexican ore, which was a supply for ten years. Every student had an

opportunity of actually performing this experiment under varying conditions at trifling expense, and the apparatus was so perfect that results equal to the best mill-practice were obtained. The provision of a museum, well-equipped with fine models of mechanism and mine-machinery which students walked by every day, must have great influence for good, in familiarizing them with good practice. The insertion of lectures on mining, very early in the course, must be of great benefit in awakening the interest in professional things at an early stage, supplying the students with the zeal needed to carry them over the less attractive non-professional work: this was a plan that other schools would do well to copy.

Mr. L. T. O'Shea (Sheffield) wrote that he had read Prof. Redmayne's paper with much interest, and had no doubt that it would receive considerable attention from all responsible for mining education, since it appeared at a time of considerable activity in that branch of technological instruction, caused, doubtless, by the foundation of local universities in industrial centres, and by the recognition of courses of studies in the qualifications for a first-class manager's certificate.

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's examinations in the principles of mining, were qualified teach the subject for those examinations, and, from the ure of their calling and previous training, were well able to part the information that they had acquired. Teachers of this ass were practically non-existent in Derbyshire and South orkshire, and, in the writer's opinion, should not be encouraged. 2) Men actively engaged in mining, with a sound practical nowledge of what they had to teach, but who, in many cases, ut by no means in all, lacked the skill of imparting that knowledge. For eight or nine years special classes had been held at University College, Sheffield, for training such men in the art of teaching, and he (Mr. O'Shea) had, in a large number of cases, been surprised at the rapidity with which students attending them had profited by the instructions. In his (Mr. O'Shea's) opinion, the man of practical experience who could teach was the more desirable instructor for a local class, but it was generally impossible for him to leave his daily occupation to join day classes, and unless the university opened its doors to him in the evening or on Saturday afternoons, it seemed to him (Mr. O'Shea) that an important influence on mining education would be lost.

In venturing to offer one or two criticisms on the course actually prescribed by Prof. Redmayne, he (Mr. O'Shea) assumed that it was a degree course; this was implied, though it was not very definitely described as such in the paper. He (Mr. O'Shea) could not help being struck with the large amount of time that was devoted to pure science, in comparison with that given to applied science. Two out of the three years were devoted to the study of mathematics, geology, physics (including electricity and chemistry, while one year only was given to mechanical and electrical engineering (presumably including steam and workshops), metallurgy and metallurgical laboratory. Only in the case of mining, and the civil engineering cognate to it, was instruction given in more than one year. He would like to ask Prof. Redmayne whether he thought that a student was likely to profit by so short a training, in such wide subjects as those taken in the third year. He (Mr. O'Shea) was prepared to admit that the scientific training of a school-boy was, in most instances, practically worthless, but he would have thought that in laying down a three years' degree course in mining it was possible for a university to insist that the student who entered that course

should have such a knowledge of the pure sciences cognate to the subject that it would be unnecessary to devote more than one year to studying the more advanced branches of heat, chemistry, electricity and mathematics, so as to allow him to obtain a more efficient training in the applied sciences than appeared to the writer possible in one year.

The question of scientific training was a most difficult one for the teachers of applied science, owing to the insufficient training in schools; and until there was an improvement in that respect he (Mr. O'Shea) was afraid that the candidate for a degree in applied science would be compelled to spend one, if not two years in obtaining the necessary proficiency in pure science before he commenced his degree course.

He (Mr. O'Shea) was interested to see the manner in which Prof. Redmayne provided for practical experience in mining operations, and agreed with him that in a degree course this should be obtained during the vacation. Whilst, doubtless, there was something to be said for giving the student the opportunity of seeing the various methods of working in different districts in this country, he (Mr. O'Shea) was rather afraid that only a very superficial knowledge would be obtained in this way, and was inclined to favour the practice of insisting on the candidate for a degree spending his vacations at a mine, feeling that in this way he would get a better knowledge of practical mining. In fact, he (Mr. O'Shea) was not sure whether it would not be still more satisfactory to confine the courses of studies during the last year to six months, and let the student spend six months at the mine. A somewhat similar system had been working now for two years in the Engineering Department of University College, Sheffield, whereby the engineering pupils of one of the large firms in Sheffield devoted the six months, from October to March, to attending the College classes in engineering and its allied subjects, and from April to September to practice in the workshops of the firm. Although this was not a degree course, it would serve to show that such a scheme was practical; and with certain modifications, perhaps, might be applied to degree courses in technological subjects.

In discussing the diploma course, if he (Mr. O'Shea) had rightly understood Prof. Redmayne's scheme, it would seem that students wishing to qualify under the Coal-mines Regulation

Act (1887) Amendment Act of June 30th, 1903, must take the first two years of the degree course which, with the exception of time spent in instruction in mining, and engineering and machine-drawing, were wholly devoted to pure science. It was, doubtless, a very difficult thing to decide how much pure science a student must know before proceeding to study its applications, but, in training students for the office of mine-managers, the writer would have thought that the amount of pure science taught them should be such as not to require the total exclusion of such subjects as steam, fuel, and mechanical and electrical engineering. These subjects were of the utmost importance to mine-managers, who were daily confronted with problems in them which required solution. The time for instruction was, doubtless, short. It was, therefore, all the more necessary to make a compromise, and balance the subjects of pure and applied science more equally than appeared to have been done in the course at Birmingham. The plan adopted at University College, Sheffield, was to insist on a certain standard of scientific knowledge before the student entered upon his diploma course, and if his knowledge did not reach this standard he was required to take a preliminary course in pure science before he became an articled pupil. That was one way of meeting the want of efficient scientific training in schools, but it was open to the objection that the student had to wait a year before he could enter upon the diploma course.

With regard to practical experience in mining operations for the diploma course, Prof. Redmayne had followed the plan generally adopted by other mining schools, namely, of requiring the student to spend two months in each year of the course in gaining that experience, or to have had at least four months of such experience before entering for the diploma. There was a strong consensus of opinion among mining engineers in South Yorkshire and Derbyshire that the candidates for the diploma should carry on their studies whilst actively employed at a mine, and the course at University College, Sheffield, had been arranged to enable them to do this, at least to a certain extent, by spreading the first year's course over two years, during which the student spent two days a week at the College, and the remaining time at the mine. During the last year, the student spent his whole time at the College. It

emained to be seen how this system would work. He (Mr. O'Shea) was inclined to think, from his experience in past years f similar classes, that the method adopted in Sheffield would e beneficial both to the teacher and to the student. It helped the itter to keep up his interest in his studies, to follow more eadily its technicalities, and to appreciate the value of the istruction. On the other hand, it might be said that this ivision of theoretical and practical instruction was distracting to ie student, but he (Mr. O'Shea) believed that the closer the cture-room and the workshop were brought together, the better would be for technological instruction.

In offering these criticisms on Prof. Redmayne's paper, he Mr. O'Shea) would like to thank him for the opportunity, which e had given to all interested in the subject, of discussing a con-ete example of a course of mining studies; and, though he Mr. O'Shea) largely differed from him, he wished every success the efforts made by the Mining Department of the University Birmingham.

Mr. EDWARD P. THOMPSON (M.E., class 1878) had written the llowing remarks on "The Stevens Curriculum."* What more nely subject could be presented for discussion by the alumni, an up-to-date changes in the curriculum at Stevens? Each umnus should speak from his own standpoint, and from these ried experiences, President Humphreys and the faculty may ean useful and suggestive hints. . . . Experience in the emical laboratory is practically useless for the mechanical electrical engineer, or, indeed, for the steam or any other gineer. He (Mr. Thompson) was not condemning the prin-ples of chemistry; no, let a brief book-course be given, but thing more. To know how to analyze, and to compound emicals is of use only to a chemist; for when, except upon rare casions, is an engineer ever called upon to analyze? He knows ough, on the contrary, to engage an expert chemist. He ight as wisely become a pharmacist as a chemist. This is e age of specialists. The excessive time spent in this depart-ent should be devoted to studies a thousand times more import-nt. He made this point, not because he did not appreciate the alue of the knowledge of chemical analysis, but because the hours

* *Stevens Institute Indicator*, 1904, vol. xxi., pages 290-293.

thus expended by the student meant a loss of absolutely necessary expert culture in regard to polyphase currents and steam-turbines, how to write specifications for plants, business engineering, Hertzian waves in wireless telegraphy, air-brakes, machine-design, shop-practice, telephone systems, wiring for electric lighting, pumps, instruments of precision, drafting, etc., almost without end. An hour a week for one or two years only, to serve as a means of an intelligent understanding of the composition of bodies, would be sufficient. Cut down on practical chemistry, thus leaving more time also for physical culture, to which many alumni attended most aptly at the mid-winter meeting.

As he looked back, he could sift out another element, valuable in itself, but comparatively useless in his line. After he graduates, the engineer can read Guizot's *History of Civilization.** To study that volume, or any similar treatise, at Stevens, is as inappropriate as to delve into Homer. They are both valuable, but pray leave something to amuse the graduate. He was happy to admit that he made a speech at his class-cremation of Guizot's work. Do not imagine that he was condemning English literature, far be it from any graduate of his beloved Alma Mater to make such a mistake, but let us remember what Gladstone says: "The proper work of universities, could they perform it, while they guard and cultivate all ancient truth, is to keep themselves in the foremost rank of modern discovery;" therefore, he (Mr. Thompson) repeated emphatically, cut down the time given to old English literature, and then put only a few of the precious moments upon practical and modern English composition by a kind of laboratory practice.

He was personally devoted to reading, as a pastime, and he pronounced it most valuable to one's education, development and usefulness, but it could as truly be said that astronomy or physiology are desirable acquisitions, but they are out of place at Stevens. So too, every book like *Don Quixote*, or criticisms thereof. As far as utility in assisting to design electric-light plants is concerned, would not Mark Twain's works prove equally helpful? The very same youths, who while at college, hate Thackeray and his tedious genealogies, will appreciate and enjoy his clever sarcasms a few years later in life.

He (Mr. Thompson) ventured another thought. If you do not

* This work is not at present studied at the Stevens Institute of Technology.

ense with the study of foreign languages, curtail the time ·bed by them. He faithfully pored over three tongues, but as now obliged to pay others to translate specifications for gn patents, and, even if he could translate, it would be omy to engage a specialist. At the best, our students need enough of a knowledge of other languages than their own, to le those who are to live abroad, to pick it up more readily, carcely any engineer needs to speak a foreign language in the ed States. Too much time is necessary to enable him to read sufficient accuracy to swear to the exact meaning. Out of alumni, there are only 13 living in foreign-speaking tries. With regard to reading foreign periodicals, simply iem wait a week for translations of the best in the American rs.

he amount of attention bestowed upon pure mathematics l have been contracted to advantage while he was a student; he would urgently add, "go slowly in this department." At ime, one class was given one quarter of a book as a lesson; nuch was always assigned for one day's work. Prof. Wood rked that he was instructed by the faculty as to the subjects studied. He counted the remaining days, and then divided number of pages to be gone over by the number of days

Often, the lessons for one day consisted of from ten to ty pages of difficult mathematics. This is a science which ot be crammed. A little of it, carefully studied, develops mind, whereas, too much befogs the brain. Those of a iematical turn of mind will press their studies in this direc- more deeply subsequently. He realized, now, that the ulus he struggled with was too advanced for any youthful ers. Teach only a primer on this subject, and then stop. By following these modestly-submitted suggestions, there be time left not only for greater health, happiness and ition among the boys, but the essentials of engineering may receive proper attention. His opinion was that Stevens was ace where young men, during only four years of their lives, o take advantage exclusively of the direct personal teaching ghly technical professors, admirable engineering shops, the us laboratories, the scientific library, mechanical drawings, isits to manufactories and plants, and, last but not least, of ymnasium and ball-grounds, which he earnestly hoped

might soon be in evidence at Stevens. Personally, he would eradicate all else; if any student wanted further development in—for example—astronomy, physiology, history, literature, languages, book-keeping, typewriting, theology, etc., he would say, "You will probably have ten times four years or more, after graduation, for reading upon any topic you please."

This finished his line of attack, but he would like to add a postscript concerning electrical engineering, and also upon the degree which the Stevens Institute confers. Electrical engineering is no more a separate profession than is steam engineering: dynamos, meters or motors, and all electric instalments are composed of machines in the same sense that any mechanical engineering plant is. M.E. means that the possessor of the title is engaged in the profession of "machines," using that term broadly. Mining and civil engineering are quite different. The machines, however, in those departments fall under the general term, mechanical engineering. Therefore, the latter includes everything relating to machines, or to the machinery of all the other engineering professions. This statement may be somewhat exaggerated, not so, however, in regard to electrical engineering. This, together with steam engineering, pumps, turbines, water-wheels, and a hundred other specific departments or devices, constitutes mechanical engineering. The trouble is with the meaning generally attributed to the degree M.E. Unfortunately, a man is not considered equally as learned in electricity if he has M.E. alone after his name. An amendment is necessary. Perhaps our graduates could have two degrees, M.E. and E.E., or more simply M.E.E. Let them think over this important matter of the graduation-title, and select a more appropriate and comprehensive degree.

Prof. R. A. S. Redmayne, replying to the discussion, said that he was very much obliged to the members for so kindly receiving his paper. The question of housing the students was one of great importance, and he thoroughly agreed with Mr. Mills in what he said in that respect. He (Prof. Redmayne) trusted that in the near future the Council of the University of Birmingham would see its way to establishing hostels, worked under proper supervision, for the benefit of students coming from a distance: graded hostels, such as were to be found at Harvard University

n the United States of America, seemed best suited to the xigencies of the case. But, he might add, that already a eginning had been made at Birmingham, inasmuch as twenty r thirty University students had found accommodation—hrough the kindness of its warden—in Queen's Theological ollege, and a hostel for women students, now under the able uidance of Miss Fry (University House), had been established ecently, was well filled, and about to be extended.

He was in full sympathy with Mr. Mills in thinking that here should be included in the mining syllabus of the University everal optional languages, such as French, German or Spanish, knowledge of any one of which should constitute a necessary art of the student's course. The difficulty was to get everyning into a three years' course. Personally, he thought that ventually the course would have to be extended to four years; d that being so, languages would at once come into the rriculum. Even, however, as matters now stood, a student shing to take the degree course had to be matriculated in the ulty of science, and then he had, amongst other things, to pass me modern language, as well as English.

As regards the machinery, therein, of course, lay a great iculty, as in any establishment the machinery must, say, at the of every 10 years or so, become more or less out of date. There uld be difficulties in the way of changing much of what he ght call the permanent plant, but, after all, this was only a all part of the machinery equipment which would be contained hin the walls of the University. And there would be proed a great hall of machines, through which machinery of the est types, lent by manufacturers, would be continually sing.

Mr. Binns had alluded to the important question as to ether a student should come direct from school to his college ining in mining, or whether he should go first of all to the ne. Personally, and in this perhaps he was biassed owing to long connection with the practical management of mines or to his undertaking professional work, his own leaning was wards one year being allocated to practical work at the mine fore the student proceeded to the University. One would like be able to follow out the idea of carrying on concurrently the eoretical and practical training of mining students, as

suggested by Mr. Coke, that was to say, that the student should work at the mine and take classes at the University. Some of his (Prof. Redmayne's) students did so, but they came under the head of occasional students, that is, those who took only one or at most two of the subjects specified in the course; others had tried to take the full course without leaving the mine, and had found that they had to neglect the mine entirely *pro tem.* Experience showed that the diploma and degree courses would not allow of the carrying on at the same time of any work other than that laid down in the mining syllabus. By means of the summer school in the vacation, and the frequent visits during term time to mines in the neighbourhood of Birmingham, apart from laboratory work altogether, a considerable amount of practical knowledge was inculcated. During a part of the vacation, those students, who had not had at least 4 months' experience at a mine, went to some neighbouring coal-mine or metal-mine for continuous practical work.

As stated by Prof. H. Louis, doctors sometimes differed, and fortunate indeed it was that they did so, as the patient (student) occasionally survived as the result of the difference! He did not expect that any person endowed with common sense would suppose that students were sent out from the University ready to undertake every duty, or that they produced ready-made teachers of mining; for, just as the man who had been trained entirely in practical work would, in the great majority of instances, be incapable of teaching others, so also would he, who had had an entirely theoretical training, be unable to do so. Prof. Louis stated that "he was entirely opposed to any slavish imitation of the systems adopted in Germany, America, or any other country," and Mr. Galloway wrote that "while reading Prof. Redmayne's paper, the words 'Columbia University' occurred to him more than once before he arrived at the reference to that institution." Might he (Prof. Redmayne) be permitted to state that, in the designing of the mining laboratories, choice of apparatus and framing of the curriculum, there had been no imitation, slavish or otherwise, of any other existing institution. He (Prof. Redmayne) some time ago made a tour of inspection of the most prominent of the American scientific universities, and acknowledged with gratitude the valuable information which he there obtained, some of which he put into practice; but any one who

ıad studied the mining curriculum in vogue at Columbia Jniversity, or walked through its laboratories, would perceive mall similitude between the mining scheme in practice there ınd that of the University of Birmingham. The conditions hat had to be met were so different in the two countries, that ·hat would be a suitable school in the one would not be so a the other, and *vice versa*. Far from leaving coal-mining in he background, that branch of mining occupied, if anything, he more prominent place, both in the curriculum and in the ıboratories at Birmingham, as he (Prof. Redmayne) would be elighted, at any time, to prove to Mr. Galloway, by conducting im over the new buildings, and sending, for his perusal, a copy f the mining syllabus in which the curriculum was set forth ı detail.

Prof. Hardwick's tables are of much interest and should serve ıore than one useful purpose, but they are incomplete in so far s they relate to the University of Birmingham, in that the hours evoted to practical work during the week-end (Saturday) visits) mines in the neighbourhood are not included. During these aturday visits, several hours are spent underground with the rofessor. Nor is mention made of the degree course, the last ear of which is of a very practical nature. His (Prof. ledmayne's) experience had been that more mining students ntered for the degree course (necessitating matriculation) than or the diploma course.

He (Prof. Redmayne) was particularly gratified by the commendation of so able a mining engineer as Mr. James S. Dixon, who had done more for the advancement of mining education n Scotland than any other living person.

Referring to Prof. Arnold's very interesting and valuable ·riticisms, the first was perhaps best answered by stating exactly ıow the student's time was divided, and this was shewn by the ollowing time tables, which would also serve the purpose of meetıg Dr. R. Mullineux Walmsley's objection.

As to the power required to work a large mining laboratory, rof. Arnold appeared to be labouring under the mistaken imession that this should be the same for mining as for metallur·al laboratories; but this was not so, as a comparison of the rela- e powers in each instance in the largest American university ıing and metallurgical laboratories would show, for the nature

of the work was absolutely different. In respect to the exclusion of evening classes from the curriculum of the University of Birmingham, he would remind Prof. Arnold that the want in the Midlands and Birmingham in this direction was admirably met by the Birmingham and Midland Institute, a splendidly equipped institution in the city of Birmingham.

TABLE V.—FIRST YEAR'S COURSE FOR THE DEGREE IN MINING.

Subjects.	Class Hours.					
	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
Mathematics, I.	12·30 to 1·30	11.30 to 12·30	—	11·30 to 12·30	12·30 to 1·30	—
Physics, I.	11·30 to 12·30	—	11·30 to 12·30	—	11·30 to 12·30	—
Physical laboratory ...	2·30 to 4·30	—	—	—	—	—
Geology, I.	—	9·30 to 11·30	—	9·30 to 11·30	—	9·30 to 11·30
Mining, I.	—	3·0 to 4·0	—	—	3·0 to 4·0	Excursions to mines in the locality, or out-door survey-work.
Surveying and planning	—	—	2·30 to 4·30	—	—	

TABLE VI.—SECOND YEAR'S COURSE FOR THE DEGREE IN MINING.

Subjects.	Class Hours.					
	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
Chemistry, I.*	9·30 to 10·30	9·30 to 10·30	9·30 to 10·30	9·30 to 10·30	—	—
Chemical laboratory ...	2·0 to 5·0	—	—	—	2·0 to 5·0	—
Geology, II.	10·30 to 11·30	—	10·30 to 11·30	—	10·30 to 11·30	—
Geological laboratory ...	11·30 to 12·30	—	11·30 to 12·30	—	11·30 to 12·30	—
Engineering drawing ...	—	—	2·0 to 5·0	—	—	—
Mining, II.	—	10·30 to 11·30	—	—	—	Visits to mines in the neighbourhood, or out-door survey-work
Surveying and planning	—	—	—	2·30 to 4·30	—	
Mining laboratory ...	—	2·0 to 5·0	—	—	—	

* Winter and spring terms.

TABLE VII.—THIRD YEAR'S COURSE FOR THE DEGREE IN MINING.

Subjects.	Class Hours.					
	Mon.	Tues.	Wed.	Thur.	Fri.	Sat
Mining, III.	10·30 to 11·30	—	—	—	10·0 to 5·0	Visits to mines in the neighbourhood.
Mining laboratory ...	2·0 to 5·0	—	—	—	—	
Engineering, I.	—	11·0 to 12·0	—	11·0 to 12·0	—	—
,, II.	—	12·0 to 1·0	—	12·0 to 1·0	—	11·0 to 1·0
Electrical laboratory and steam-engineering practice in power-station	—	2·0 to 5·0	—	2·0 to 5·0	—	—
Metallurgy, II.	11·30 to 12·30	—	11·30 to 12·30	—	—	—
Metallurgical laboratory	9 hours a week by arrangement.					

He was much interested in Mr. J. T. Beard's description of what was being done in America in the way of mining instruction. Instruction by correspondence appeared to be as great a boon there as it was in Great Britain. He would like to say, for the information of Mr. Beard, that mining students were constantly practiced in and urged towards making freehand sketches of machinery and mining appliances, as well as instructed in the accurate plotting and planning of surveys and sectional levellings.

Referring to the experimental mine, Mr. F. W. A. Thomae said that it was questionable whether instruction in mine-surveying "could not have been obtained more efficiently and at far less cost by taking the students for a short time to a mine, and teaching them there under actual working conditions." Just as efficiently, certainly, but at a less cost, certainly not. Did Mr. Thomae know of any mine-owner who would hand over his mine, for a small "consideration," for the purpose? He (Prof. Redmayne) had had over 20 years' practical experience in the daily management of mines, many years of which were spent in England, and he had not yet met such a mine-owner. Nor, were he a mine-owner, would he be inclined to grant such privileges, and, in a manner, be responsible for the safety of, perhaps, more or less untrained and youthful students.

In conclusion, he (Prof. Redmayne) sincerely thanked all se who had so kindly and with so much insight, criticized his per. The scheme of instruction which he had described he it was by no means perfect, but *experientia docet* was a true ying, and he was sure that not the least valuable of his xperience would be that due to the present interesting and ble discussion.

The CHAIRMAN (Mr. J. C. Cadman) moved a vote of thanks to Prof. Redmayne for his interesting paper.

Mr. C. C. LEACH seconded the resolution, which was cordially approved.

DISCUSSION OF MR. H. F. BROWN'S PAPER ON "A NEW PROCESS OF CHLORINATION FOR MIXED GOLD- AND SILVER-ORES."*

Mr. E. O. WATT (Kalgoorlie, Western Australia) wrote that Mr. Brown was deserving of the thanks of the metallurgical world for introducing a new process that gave promise of revolutionizing all present practice in the chlorination of gold-ores and silver-ores; but, with all due respect to so able an authority, he must question his conclusions when he stated that "during the operation of this chloridizing roast, there is usually a very great, if not practically a total, loss of the gold-contents."† This statement appeared to be extreme, and out of proportion to the true condition of affairs, so far as Australian practice was concerned. While admitting that, perhaps, Australians had not had a very extensive experience in the chloridizing of ores in which the silver-values predominated over the gold-values, still the process had not been neglected in their part of the world. At Booroo k, in New South Wales (the first silver- and gold-mine commercially worked in Australia), at the Webbs mine, at the Clyde works, and in several other places, the process had been worked for a longer or shorter period of time; and, so far, his personal experience and other data indicated that in no case did the loss of gold exceed 20 per cent. of the total contents. However, it could not be overlooked that, under the circumstances indicated by Mr. Brown, the loss of gold-contents had always been serious

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 529. † *Ibid.*, page 529.

enough to call urgently for some amendment of existing processes. He thought that modern experience indicated pretty clearly that under all circumstances, when dealing with volatile combinations of precious metals, it paid to bottle up such volatile gases, if by any means this end could be economically accomplished. Mr. Brown gave a sketch of a receiver for this purpose, which, with slight modification for the purpose of overcoming dusting, should prove very effective. As Mr. Brown's sketch only pretended to show a possible arrangement for a small plant, it might not be fair to criticize it too closely; but, with the exception of the receiver, the whole of his suggested mechanical arrangements were extremely crude, and to the engineers of Kalgoorlie, who had had large experience in automatic rabbling, cooling, and conveying of hot and cold ores, they must appear ludicrously out of date. He thought that Mr. Brown was conscious how greatly his process might be expedited by such highly efficient automatic arrangements as those that obtained on this field, and in any case he deserved the thanks of the members for introducing a process of such novelty and high possibilities.

Mr. G. M. Roberts (Kalgoorlie, Western Australia) wrote that Mr. Brown's contention that large losses occurred in the roasting of argentiferous gold-ores with an admixture of salt agreed with his experience. Experiments made upon the sulphotelluride ores of Kalgoorlie, roasting without salt, showed no appreciable loss of the gold-values; but with salt added the losses were enormous, as much as 50 per cent. of the gold-values being carried away. The methods now in use were practically free from losses by volatilization, but a small mechanical loss occurred by dusting. The process outlined by Mr. Brown would not be applicable to the Kalgoorlie ores, on account of the large percentage of lime contained in the ore, principally as calcite and gypsum veinlets. Several of the mines at Kalgoorlie, however, were producing concentrates and these would be amenable to chlorination processes. He (Mr. Roberts) was, however, doubtful whether Mr. Brown's process would do more economical work than the method in use at the present time which was, briefly, as follows:—The concentrates are roasted in mechanically-rabbled furnaces (two types of furnace are in use, namely, Edwards and Merton) without the addition of

salt, and the roasted ore is conveyed to the grinding and amalgamating pans in a partially cooled state. The pulp leaving the pans is passed through spitzkasten, used for thickening the pulp to a consistency of one part of dry pulp to one part of solution: this thickened pulp is conveyed to agitators, and treated for about 18 hours with cyanide solution, and then filter-pressed in the ordinary way. The extractions are very high, but the residues are usually stacked for retreatment, costing from 3s. to 5s. per ton. The final total extraction averages 97 per cent. On the mine of the Associated Northern Blocks, Limited, no concentrators are in use, it being considered more economical to roast the whole of the ore mined from below the oxidized zone, and, up to now, this method has given excellent results. The whole of the ore is dry crushed (ball-mills with 25 mesh-screens are in use). It is then roasted in Merton furnaces, amalgamated, agitated with dilute cyanide solutions, and filter-pressed in the usual manner. The extraction is high, and the total treatment costs 15s. per ton.

Mr. Brown's cylinder for chlorinating the roasted ore was unique, and would be highly appreciated by metallurgists who had mixed gold- and silver-ores to treat. The method shown in Plate XXIII.* for conveying the ore to the cylinders and for discharging it, was a rather crude one. A much better device was the push conveyor, now so largely in use at Kalgoorlie: it would convey any kind of crushed material at any temperature, and very little dusting occurred; it was also a splendid cooler.

DISCUSSION OF MR. G. F. MONCKTON'S PAPER ON THE "CINNABAR-BEARING ROCKS OF BRITISH COLUMBIA."†

Mr. G. F. Monckton (Savonas Ferry, British Columbia), replying to the discussion, wrote that the only mines in the district which had been developed with any considerable amount of capital were those of the British Columbia Cinnabar-mines Company and of the Hardie Mountain Mines, Limited, at Copper Creek, and the total amount expended on them (about £16,000) would be considered a trifle to develop a South African mine. Equally

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 534.

† *Ibid.*, page 463.

promising outcrops of ore occurred at a number of other places, where work had only be done on a very small scale. The system suggested by Mr. W. D. Verschoyle, of grouping a number of mines round a central reduction-works, was one which would be very suitable to the district. In Copper Creek, the natural slope of the mountains bordering the valley would enable such a central plant to draw its supplies of ore from a district, 8 miles long and 3 miles wide, by gravity. The most favourable situation for the furnace would be near the lake, in this case. The occurrences of cinnabar on Criss Creek were in an even more favourable position, as the valley crossed the quicksilver-bearing zone and the river cut through it at a greater depth. About 12 square miles would be tributary to a central reduction-works at this point, some of the deposits being nearly 2,000 feet above it. A large amount of water-power was available on this river, which would be of value if the reduction of quicksilver-ores by electricity proved to be a success. Should ore be found on Deadman river, as appeared likely, the same remarks would apply to that area. The greater part of the zone remaining was tributary to the deep valley of Three Mile Creek, in which also one or more reduction-works might be established. The simplest method of discovering the ore was by trenching across the direction of the streaks, which seemed to be always nearly north and south. Diamond-drills should also work satisfactorily. So little prospecting had been done that it was difficult to say what was the probable extent of the ore-deposits, but important deposits had been found over a length of more than 30 miles. Prospecting for cinnabar required closer attention to the ground than ordinary prospectors gave. The veins carrying the ore might be said to average 1 or 2 feet in width, and carry as a rule 1½ to 5 per cent. of quicksilver. Wider and lower-grade deposits also occurred. He (Mr. Monckton) had the pleasure of accompanying Mr. J. D. Kendall in his visit to the property of the British Columbia Cinnabar-mines Company, and would point out that at that time he (Mr. Monckton) could only say of that mine, "a considerable sum has been spent at the mouth of the [Copper] creek in mining in these rocks, but without success. A furnace was built to treat the low-grade ore, with the result that one may now wash out quicksilver in the creek below it. Parallel levels were driven into the mountain-side, and the

works now resemble a huge rabbit-warren. Under the earlier management, they produced 7,865 pounds of quicksilver from high-grade ore."* In the following year, the owners expended a small sum of money in uncovering the streaks of ore referred to in the paper under discussion. Some of these were merely covered by waste-rock from other workings, and were very high grade, one of them yielding 8 per cent. ore. He (Mr. Monckton) had no reason to suppose that the high-grade streak originally worked was exhausted when the small furnace was dismantled. The sample of low-grade ore, assayed by Mr. Kendall in 1896, was not likely to have come from any of the deposits called ore by him (Mr. Monckton) as they were not worked at that time, the deposits which were worked not being worthy of the name of ore. The list of sinkings and driftings given by Mr. Kendall, in order to show the worthlessness of the deposits, was also somewhat misleading, several of the items referring to properties many miles distant, which were never visited by him. Moreover, in accounts, the list of expenditures did not show the position of a business unless it was accompanied by the list of receipts, so in the case of a mine, the list of ore-bodies found should be compared with the amount of work done. On the British Columbia cinnabar-mines, ore was found in upwards of twenty places. In his (Mr. Monckton's) opinion it could not yet be said even of the one mine visited by Mr. Kendall that these deposits were not economically interesting; much less could such a definite opinion be expressed of the district as a whole, seeing that the ore had been found over 40 square miles and only one little corner of this had had any capital expended upon it. He (Mr. Monckton) hoped and believed that in this case Mr. Kendall's judgment might be for once found at fault.

Mr. G. A. Stonier read the following paper on "The Bengal Coal-fields, and some methods of Pillar-working in Bengal, India":—

* *Trans. Inst. M.E.*, 1899, vol. xviii., page 306.

THE BENGAL COAL-FIELDS, AND SOME METHODS OF PILLAR-WORKING IN BENGAL, INDIA.

By GEORGE A. STONIER, A.R.S.M., F.G.S.,
Late Chief-inspector of Mines in India.

I.—Indian Coal-fields.

Introduction.—The coal-output of India has wonderfully increased during the last 23 years. In 1880, only 1,020,000 tons were raised; while for 1903, the output totals 7,374,000 tons, valued at 21,754,000 rupees, and the industry employed nearly 88,000 persons daily. Coal-bearing strata in India are of various geological ages: Cretaceous and Tertiary beds yielding 4½ per cent.; and the Gondwana beds (Permo-Trias), 95½ per cent. of the output of this mineral.

In 1903, the province of Bengal furnished nearly 6,298,000 tons (or 85½ per cent. of the total output for India) entirely from the Gondwana beds, which may be conveniently divided into an Upper Coal Series (or Raniganj of Dr. W. T. Blanford) and a Lower Coal Series (or Barakar of Dr. W. T. Blanford). The former yielded 2,230,000 tons and the latter contributed 4,068,000 tons. Four companies mined 31 per cent. of the production, 82 per cent. was mined from European and 18 per cent. from Indian owned collieries. Table I. shews the output and the labour employed during 1903.*

Table I.—Coal-output and Labour Employed during 1903.

Name of Coal-field.	Distance from Calcutta by Railway.	No. of Mines.	Coal.	Number of Workpeople								Totals.
				Underground.				Aboveground.				
				Men.	Women.	Children under 12 Years.	Total.	Men.	Women.	Children under 12 Years.	Total.	
	Miles.		Tons.									
Jherria ..	178	103	2,424,127	10,600	6,501	648	17,749	6,103	3,552	656	10,311	28 060
Giridih ..	206	9	766,871	5,436	2,213	90	7,739	2,157	618	179	2,954	10,693
Raniganj ..	120 to 145	144	3,072,915	16,806	5,992	423	23,221	6,401	3,827	429	10,657	33,878
Daltonganj	453	2	33,557	697	125	1	823	262	133	17	412	1,235
Rajmahal	136	4	335	6	4	—	10	17	7	—	24	34
	Totals	262	6,297,805	33,545	14,835	1,162	49,542	14,940	8,137	1,281	24,358	73,900

* For previous years, see the *Report of the Chief Inspector of Mines in India.*

Jherria.—The Jherria coal-field, opened in 1894, has an area of 180 square miles* in the form of a lozenge, pointed at both ends. The formations in descending order are:—

(1) Raniganj or Upper Coal Series, with two seams, each 6 feet thick: they were not worked in 1902, but were mined in 1903.

(2) Ironstone Shales, without coal-seams, 600 to 1,600 feet thick.

(3) Barakar or Lower Coal Series, with at least 18 seams, varying from 5 to 30 feet in thickness, and numbered in ascending order. Twelve seams are being worked, and their output is as follows:—Nos. 7 and 8, 17,400 tons; No. 9, 1,800 tons; No. 10, 107,000 tons; Nos. 11 and 12, 155,400 tons; Nos. 13 and 14, 1,261,000 tons; No. 15, 734,800 tons; No. 16, 76,700 tons; No. 17, 67,100 tons; and No. 18, 3,000 tons.

Strike faults are numerous, and mica-peridotite dykes have burnt the coal, in some cases passing along the seams in laccolitic form. The deepest shaft is 320 feet deep. It is estimated that within a depth of 1,000 feet, there are 168,000,000 tons. The average value at the pit's mouth during the year was 2 rupees (2s. 8d.) and the freight to Calcutta is 3 rupees 11 annas 0 pice per ton.

Giridih.—The Giridih (Karharbari) coal-field,† worked from 1857 to 1861, was re-opened and systematically worked from 1871. It has an area of 7 square miles, containing two valuable seams and several thick dirty seams (hill seams): all being in the Barakar or Lower Coal Series. The output is derived from the lower seam, which varies from 30 to 12 feet in thickness, and contains the finest steam-coal in the Gondwana system. The upper seam is 6 to 10 feet thick, and has been worked by the East Indian Railway Company.

The total amount of coal is estimated at 124,000,000 tons, and after deducting 25 per cent. for loss by faults, etc., and 17,500,000 tons raised to the surface and lost in working from 1857 to 1903, the remaining available coal, 75,500,000 tons,

* "The Jherria Coal-field," by Mr. Theodore Hughes, *Memoirs of the Geological Survey of India*, 1866, vol. v., page 227; and "Report on a Survey of the Jherria Coal-field," by Mr. Thomas H. Ward, *Records of the Geological Survey of India*, 1892, vol. xxv., page 110.

† "The Giridih (Karharbari) Coal-field, with Notes on the Labour and Methods of Working Coal," by Dr. Walter Saise, *Records of the Geological Survey of India*, 1894, vol. xxvii., page 86.

ıews a life of 98 years for this coal-field at the present rate of ıtput.

One shaft is sunk to a depth of 640 feet (the deepest coal-haft in India), and nearly all the coal is wound by modern lants. The coal yields a good coke. A briquette-plant is in ′orking order at one mine.

Raniganj.—In 1774, Mr. S. C. Heatley (the reputed dis-:overer of coal in Bengal) and Mr. J. Summer applied to the ;overnment for the right of working coal at Raniganj. In 1777, six mines were worked and 90 tons of coal were obtained. Nothing further was done till about 1815, when Mr. Jones mined oal from pits, and was the first to sell it in the general market. 'he industry progressed slowly until 1840, when the quantity ·nt to Calcutta from Raniganj reached 36,200 tons. From 340 to 1845, there was a constant increase in the output, which 1845 amounted to 62,400 tons. The East Indian Railway ɔped the coal-field in 1854; and, in 1858, the output had :reased to 220,000 tons. In 1903, 3,073,000 tons were raised m 144 mines employing 33,900 persons daily.

The eastern boundary is covered by alluvial deposits, and has ; been defined, but the area, as mapped by Dr. W. T. Blanford 1863, covers 500 square miles. The valuable Upper and wer Coal Series are separated by Ironstone Shales, 1,000 feet ck. The Upper Coal Series yielded 2,376,000 tons from ten ms, divisible into upper, middle and lower seams, which con-buted 442,000, 149,000 and 1,785,000 tons respectively. The wer Coal Series, containing at least five workable seams, con-buted nearly 697,000 tons. There are two shafts sunk to a pth of 550 feet. The dip is generally 1 in 8.

The Daltonganj and Rajmahal basins are not of so much im-tance as the three coal-fields already referred to. There are eral other valuable coal-fields, but they require railway-com-unication. A map showing the position and size of the Bengal al-fields is attached (Fig. 1, Plate XVII.).

The output of the three important coal-fields from 1888 to 03 forms Appendix A.

Appendix B records the output and labour employed for each al-field in India during 1903.

Several analyses (for which the writer is chiefly indebted to

Dr. W. Saise, the superintendent of the collieries belonging to the East Indian Railway Company) are detailed in Appendix C. The high percentage of moisture in the upper seams of the Raniganj coal-field is remarkable, and has been traced to the bituminous bands in the coal.

Appendix D shows the consumption of coal in India for the years 1880, 1890, 1900 and 1903.

II.—Methods of Pillar-working.

Introduction.—At most of the pits, the roof is good, the floor and coal are hard, and the dip is small. Gas has been detected in small quantities at five collieries. One seam is 95 feet thick, and the portions worked vary in thickness from 2½ feet to 45 feet. Longwall working was attempted some years ago in the Raniganj coal-field, but was discontinued.

As a rule, a quarry is commenced at the outcrop; and, as it pays to remove a large overburden from thick seams, a number of huge open excavations have been formed. When the cover overlying a seam is too thick to be economically removed, or when the seam is thin, galleries, from 8 to 12 feet wide, are driven, both on the dip and along the strike of the seam. It is usual to start from the top of the seam with a height of 6 feet, and after this drive has advanced some distance, to deepen it to the full height of the seam, by cutting out the remainder of the coal in successive steps. The pillars of coal, left between the galleries, vary from 12 to 40 feet, and occasionally are 100 feet square, the larger pillars being left in the case of thick seams or thick cover. They are being drawn or worked at several pits, and the following notes refer to the methods adopted at five European owned collieries.

(A) *Khooldia Colliery: Giridih Coal-field, Lower Coal Series.*—The seam, from 15¼ feet to 21 feet thick, has a band (5 feet from the roof) of coarse grey micaceous sandstone, 2 feet thick at one part, and a dark siliceous shale, 6 inches thick, in another portion of the colliery. The dip is 1 in 7. The seam has been cut into pillars, averaging 60 feet square with galleries 12 feet wide, and they are now being removed in two systems, varying according to the thickness of the band.

(1) Thick Band.—The seam, 21 feet thick, with a strong sandstone-roof has the following section (Fig. 2, Plate XVIII.):

		Ft.	Ins.	Ft.	Ins.
Roof:	Sandstone	—			
		—		—	
Seam:	**COAL**	5	0		
	Coarse grey sandstone	2	0		
	COAL	10	0		
	Shale and *coal*	0	9		
	COAL	3	3		
		—		21	0
Thill:	Shale	—			
		—		—	

band, 2 feet thick and forming a safe roof, was not vated; and the pillars of the top coal have been left verti- over the pillars of the bottom coal. The cover is 250 feet :. The cleat is practically vertical, and parallel to the dip to the goaf-edge.

he pillars in the bottom coal are worked in the manner ibed below, and the top coal is dropped. When the galleries unding a pillar in the bottom coal have been timbered props (7 inches in diameter), and lids, placed 3 or 4 feet :, the pillar is worked towards the goaf, leaving stooks at corner, 8 feet square and the full height of the bottom coal. latter, 14 feet thick, is taken in two benches each of 7 feet. arting the upper lift, holes (1½ feet deep and 3 feet apart) ut in the coal to receive one end of horizontal timbers, a are also bound by rope to the props, and support horizontal ts, forming a platform (or *machan*) on which men can stand. n the face has advanced 3 feet, the *machan* is removed. lower bench is excavated, either by the men who cut the r bench, or by fresh parties of miners. Occasionally a rib, et thick, is left against the goaf instead of two stooks. s are set while the upper lift is being worked, and are ced by long timbers as the lower portion of the coal is won. he round coal is removed by the miners, who are paid 4d. ub of 13 cwts., as soon as it has been cut; and after two aree pillars have been worked, the dust is removed by ·i coolies, paid daily. Holes are then drilled in the stooks charged with dynamite, the timber is withdrawn, and the s are fired. The band and top coal fall, and the latter is ed into tubs. The coal, forming the stooks, and covered by fallen bandstone, is also recovered. Props are placed about eet apart, and *chowkidars* (8 feet square) are left about feet apart to indicate the weighting of the roof. The goaf refully and constantly examined, and, in the case of heavy

weighting, the miners are withdrawn from the pit, until the roof has fallen (Figs. 3, 4 and 5, Plate XVIII.).

(2) Thin Band.—The section of the seam differs from the preceding in the thickness and character of the upper band, which is weak and is excavated in the process of pillar-formation. The seam has the following section (Fig. 6, Plate XVIII.):—

		Ft. Ins.	Ft. Ins.
Roof:	Sandstone	—	
		—	—
Seam:	**COAL**	5 3	
	Dark siliceous shale	0 6	
	COAL	9 6	
		—	15 3
Thill:	Shale	—	
		—	—

At one time, work was commenced from the floor, but the method was soon abandoned in favour of the one about to be described. A road (5 feet wide and 5¼ feet high) was driven in the top coal, through the centre of the pillar and parallel to the cleat and dip, at a cost of 8d. per foot. The remainder of the top coal was then worked from this drive, by two faces parallel to the cleat, and timbered. The winning of the bottom coal followed closely upon the working of the top coal. A stook, to indicate weighting of the roof, was occasionally left at one corner of the pillar. It will be noted that there were numerous working-places for the miners, and no danger from overhanging coal; and, in the case of crushed pillars, a large percentage of round coal could be obtained (Figs. 7, 8 and 9, Plate XVIII.).

(B) *Sodepore Colliery: Raniganj Coal-field, Upper Coal Series.*—The seam, 17 to 17½ feet thick, with a dip of 1 in 7, has the following section (Fig. 10, Plate XVIII.):—

		Ft. Ins.	Ft. Ins.
Roof:	Sandstone	—	
	Clay	0 0½	
	Sandstone	5 0	
	Dark shale, *nil* to	1 0	
		—	6 0½
Seam:	**COAL**	8 0	
	Dark shale, *nil* to	0 3	
	COAL	4 0	
	Dark shale, *nil* to	0 3	
	COAL	5 0	
		—	17 6
Thill:	Shale	1 6	
	Sandstone	—	
		—	1 6

The cleat is practically parallel to the dip or nearly north d south, but it has a slight westerly hade. The roof breaks ng lines which run about north 10 degrees east. Pillars e formed 40 feet square, and the galleries are made 12 feet de. The cover is 380 feet thick. Three systems have been ed, and the third has been found to be successful.

(1).—The pillars were split in both directions, close to the or, by cross-jenkins, 6 or 7 feet high. These were then idened out to the full horizontal area of the pillar, but four ooks were left, one at each corner of each pillar. Shots were ut in the stooks. As, however, not only the top coal but also feet of the roof (up to the ½ inch band of clay) came down, the ystem was abandoned.

(2).—Each pillar was won in slices, 8 feet wide and the full engths of the pillar. In each slice, the lower portion was worked o a height of 8 feet; and the top coal was then dropped by hree or four shots fired near the roof. The roof was not ffected, but it was difficult (with native labour) to remove all ie overhanging coal.

(3).—Each pillar is treated on its merits, but as a rule two three pillars are attacked parallel to the dip and worked wards the goaf. Timber is set, 3 feet apart, in the road-ys, and men, who stand on wooden stools, start a cut (8 feet gh and the full length of the pillar) in the upper portion of e seam near the roof, setting timber, and leaving, if necessary, feet of coal below the roof. When the cut has advanced 6 feet, e bottom coal is taken up, and the short timbers are replaced long props, set 3 feet apart. The whole of the pillar is moved, with the exception of a rib, 4 or 5 feet wide, left gainst the edge of the goaf, which makes an angle of about) degrees with the cleat of the coal. On the withdrawal of ie props, the roof generally falls at once, but occasionally second line of pillars is taken out before it comes in (Figs. 1, 12 and 13, Plate XVIII.). About 72 per cent. of the coal von is round coal.

(C) *Khoira Colliery: Jherria Coal-field, Lower Coal Series.*—At this colliery, No. 15 seam, 18 feet thick at adjoining collieries,

contains 10½ feet of workable coal, as shewn in the following section (Fig. 14, Plate XVIII.):—

		Ft. Ins.	Ft. Ins.
Roof:	Shale	—	
	Mica-peridotite	2 0	
	Jamma	2 0	
			4 0
Seam:	**COAL**	5 3	
	Dark shale	0 1	
	COAL	5 2	
			10 6
Thill:	Carbonaceous shale	—	
			—

The upper portion of the seam has been burnt to *jamma* (a natural coke) by dykes and laccolitic sheets of mica-peridotite. The latter, only 2 feet in thickness, lie parallel to the bedding of the coal, and have affected the roof more than the coal itself. The dip is 1 in 7, and the cleat (which is poorly developed) makes an angle of 30 degrees with the dip. A series of jacks or backs run at right angles to the cleat, but they are not very important. The cover is 50 feet thick. The pillars are 30 feet square, and the galleries are 10 feet wide. When the latter have been timbered with props and lids, 3 feet apart, the pillars are attacked in sets of four, parallel to the dip and goaf-edge; each pillar is halved and quartered by galleries, 10 feet wide, leaving four stooks, 10 feet square. Two of the latter, parallel to the dip, are worked towards the goaf: the roof is timbered as the faces advance, and, if there are signs of weighting, small ribs or knobs of coal are left against the goaf-edge. The timber is then withdrawn, and the roof falls within a few hours. The remaining two stooks in each pillar are removed in a similar manner. The galleries and stooks are worked in two lifts; and, in order to start the upper bench, the miners stand on wooden stools, 5 feet high (Figs. 15, 16 and 17, Plate XVIII.).

The surface of the ground has subsided to the full thickness of the seam, 10½ feet.

(D) *Borrea Colliery: Raniganj Coal-field, Lower Coal Series.*—There are five seams in the Lower Coal Series, 5, 3 to 4½, 35, 5 and 15 feet thick respectively, as shewn in Table II. (Fig. 18, Plate XVIII.):—

TABLE II.—SECTION OF COAL-SEAM AND STRATA AT BORREA COLLIERY, RANIGANJ COAL-FIELD, LOWER COAL SERIES.

No.	Description of Strata.	Thickness of Strata. Ft. Ins.	No.	Description of Strata.	Thickness of Strata. Ft Ins.
1	Sandstone	10 0	8	COAL, with 15 bands, *No. 3 Seam*	35 0
2	Black shale	7 9	9	White and grey sandstone ...	106 0
3	COAL, *No. 1 Seam*	5 0	10	Dark shale	45 0
4	White sandstone	6 0	11	COAL, *No. 4 Seam*	5 0
5	COAL, *No. 2 Seam*	4 6	12	White and grey sandstone ...	40 0
6	Grey and white sandstone ...	22 3	13	Dark-grey shale	9 0
7	Dark shale	4 4	14	COAL, *No. 5 Seam*	15 0

The seams crop out in the form of a horseshoe, in gently undulating country, and have been mined near the outcrop, chiefly by nclines, on a pillar-and-stall system. No. 1 seam, which conained the best coal, has been exhausted. No. 2 seam, which uickly thinned to the dip, has been very little mined. No. 3 eam is yielding a fair output from the central portion of the eam, which is burnt in places by laccolitic sheets and dykes f peridotite (?). An area of No. 4 seam has been cut into illars, which are now being won in the method described elow. The galleries of No. 5 seam extend under No. 4 seam, ut the pillars of the latter do not underlie the workings in No. 3 seam.

No. 4 seam, 5 feet thick, has a band, 3 inches thick in the entre of the section. The dip is generally 1 in 12, but the strike aries in direction. The cleat is practically parallel with the trike, but it is not well developed. The jacks or backs, which re very marked and are parallel to the dip, have a hade of 0 degrees and extend into the roof. The cover is 160 feet hick. The pillars are made 30 feet square, and the galleries re 10 feet wide. Under the railway-siding, the pillars are eing split in two directions, that is, halved and quartered by alleries, 10 feet wide, which are packed with shale won from he roof—the only case in Bengal where packing is used.

In an adjoining area, a commencement is being made to win illars in a line, which makes an angle of 45 degrees with the ip, in order to minimize the risk of accident from falls of roof etween the jacks. When the galleries have been timbered ith props, 4 to 6 feet apart, the pillar is attacked by two arties of miners (one on the rise-face and the other party on he dip-face), who work the pillar in slices, 2 feet wide, leaving rib, 6 feet thick, against the goaf, and timbering the workings

as the faces advance. The rib is then won, if the roof is safe, and when the latter begins to "talk," the timber is withdrawn and the roof allowed to fall (Figs. 19, 20 and 21, Plate XVIII.)

Two details of the work are interesting:—(1) Contrary to the usual custom in Bengal, the coal is undercut, the miners standing up to do the work. (2) The coal is loaded in the ordinary way at the face into baskets, 21 inches in diameter and 6 inches deep, but as the latter cannot be carried on the heads of coolies, they are tied to two thin poles, 7 feet long, forming a sledge, and are dragged 120 feet to a level, where tubs are run on rails.

(E) *Bhaga Colliery: Jherria Coal-field, Lower Coal Series.*—The seam is 10¼ feet thick, with two continuous bands 2 inches and 3 inches respectively thick and two irregular thin lenticular bands, as shewn in the following section (Fig. 22, Plate XVIII.):—

		Ft.	Ins.	Ft.	Ins.
Roof:	Sandstone	10	0		
	Shale	16	0		
				26	0
Seam:	**COAL**	3	9		
	Band	0	3		
	COAL	4	4		
	Band	0	2		
	COAL	2	0		
				10	6
Thill:	Shale	—			

The seam has a dip of 1 in 8, and a roof of shale, which is treacherous. The cleat is vertical and nearly parallel with the strike, but it is not well developed. The cover varies from 70 to 90 feet.

At first, an attempt was made to work the full section of the seam into pillars, but, as the cost of timbering to support the roof was high, the system was abandoned in favour of the following method, which also affords an easy opportunity of picking out the upper band.

An area is cut into pillars, 20 to 25 feet square, by galleries 8 to 11 feet wide and 6½ feet high, leaving the upper band (3 inches thick), which does not need timbering, as a roof. The pillars are then worked in groups of four, and attacked in pairs, parallel to the goaf-edge and to the dip of the seam, but

t angles to the cleat. After a single or double row of
props (5 inches in diameter) and lids has been set in the
s so as to enclose a pillar, the latter is halved and
ed by jenkins, 5 feet wide, leaving four stooks. These
kins are then timbered by props, placed 3 or 4 feet apart;
› two stooks, parallel with the goaf-edge, are worked
the latter, the upper band and top coal being supported
s. When the remaining two stooks have been excavated
› timber withdrawn, the band and overlying coal fall.
main roof is safe, coolies are sent to load the coal
into tubs or to stow it in the galleries. The main roof
ly falls about 10 hours later; and, if it does not fall,
is made on the next set of four pillars, and a rib, 6 feet
d the full height of the seam, is left to break off the roof.
und, by holing in the coal and splitting the pillars, that
cent. of the fuel mined is steam coal, and a larger per-
is won than by working on faces the full length of the
The surface has collapsed to the full height of the seam
›t) where the pillars have been extracted (Figs. 23, 24
Plate XVIII.).

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IX A.—OUTPUT OF THE THREE CHIEF COAL-FIELDS OF BENGAL FOR THE YEARS 1888 TO 1903 INCLUSIVE.

Giridih.	Raniganj.	Jherriah.	Totals.
Tons.	Tons.	Tons.	Tons.
1,380,394		Nil.	1,380,394
1,541,356		,,	1,541,356
506,560	1,119,685	,,	1,626,245
1,747,122		,,	1,747,122
1,920,050		,,	1,920,050
562,037	1,284,707	,,	1,846,744
570,331	1,413,463	14,818 *	1,998,612
2,345,761			2,345,761
666,919	1,920,741	448,524	3,036,184
660,665	2,141,857	332,740	3 135,262
653,047	2,153,172	811,833	3,618,052
625,777	2,271,054	1,131,549	4,028,380
712,727	2,519,905	1,738,795	4,971,427
691,745	2,931,688	2,076,155	5,699,588
776,656	3,053,046	2,420,021	6,249,723
766,871	3,072,915	2,424,127	6,263,913

* The first coal wrought in this coal-field.

APPENDIX B.—Coal-output and Labour Employed for each Coal-field in India during the Year 1903.

Province and Coal-field.	Output of Coal. Tons.	Number of Workpeople.								
		Underground.				Aboveground.				Totals.
		Men.	Women.	Children (under 12).	Total.	Men.	Women.	Children (under 12).	Total	
I.—Cretaceous and Tertiary.										
Assam: Makum	239,278	499	280	7	779	269	161	29	459	1,238
Baluchistan: Khost	36,444	434	—	—	434	190	—	150	340	774
Sor Range and Mach.	10,465	125	—	—	125	45	—	—	45	170
Totals ..	46,909	559	—	—	559	235	—	150	385	944
Burma: Thingadaw	9,306	13	19	—	32	23	25	—	48	80
Kashmir: Ladda	1,000	120	—	—	120	100	—	—	100	220
Punjab: Dandot	43,704	928	—	6	934	450	—	19	469	1,403
Rajputana: Bikaneer	21,944	43	1	1	45	30	18	—	48	93
I.—Totals	362,141	2,162	300	7	2,469	1,107	204	198	1,509	3,978
II.—Palæozoic: Gondwana Beds.										
Bengal: Daltonganj	33,557	697	125	1	823	262	133	17	412	1,235
Giridih	766,871	5,436	2,213	90	7,739	2,157	618	179	2,954	10,693
Jherria	2,424,127	10,600	6,501	648	17,749	6,103	3,552	656	10,311	28,060
Raniganj	3,072,915	16,806	5,992	423	23,221	6,401	3,627	429	10,457	33,678
Rajmahal	335	6	4	—	10	17	7	—	24	34
Totals ..	6,297,805	33,545	14,835	1,162	49,542	14,940	8,137	1,281	24,359	73,900
Central India: Umaria	193,277	1,225	209	—	1,434	228	8	—	236	1,670
Central Provinces: Mohpani	31,443	413	165	—	578	199	32	—	231	809
Warora	127,623	655	—	—	655	477	103	—	580	1,235
Pench River	88	15	10	—	25	—	—	—	—	25
Totals ..	159,154	1,083	175	—	1,258	676	135	—	811	2,069
Hyderabad: Singareni	362,733	3,375	734	723	4,832	1,262	149	116	1,527	6,359
II.—Totals ..	7,012,969	39,228	15,953	1,885	57,066	17,106	8,429	1,397	26,933	83,998
III. Gross Totals	7,375,110	41,390	16,253	1,892	59,535	18,213	8,633	1,595	28,441	87,976

APPENDIX C.—ANALYSES OF INDIAN COAL.

ame of Mine and Village.	Hygroscopic Moisture.	Ash.	Fixed Carbon.	Volatile Hydrocarbons.
ANIGANJ COAL-FIELD.				
oal or Raniganj Series.				
eams—				
... ...	8·36	13·78	43·29	34·57
... ...	7·00	8·00	52·00	33·00
al	7·00	15·00	47·00	31·00
... ...	8·83	22·53	40·62	28·02
apur	4·60	8·50	60·50	26·40
a	6·32	17·99	41·98	33·71
... ...	5·00	21·00	46·00	28·00
... ...	9·05	8·52	49·48	32·95
... ...	7·28	15·07	45·12	32·53
... ...	5·63	11·22	47·48	35·67
eams—				
noba : 9 Feet Seam	4·00	19·00	46·00	31·00
7 Feet Seam	4·75	19·00	45·50	30·75
12 Feet	4·75	10·00	47·00	38·25
14 Feet	4·00	13·00	46·00	37·00
anj	4·00	16·00	47·00	33·00
ir : Top Seam, 14 Feet ..	4·75	15·00	47·00	33·25
Bottom Seam, 9 Feet ...	5·00	17·00	46·00	32·00
,, ,, 16 Feet .	3·50	18·00	49·00	29·50
eams—				
... ...	2·75	11·00	55·00	31·25
mo, 8 Feet Seam	2·50	18·00	47·00	32·50
.. ..	3·65	10·05	55·50	30·80
apur	2·50	13·00	51·00	33·50
ick	5·00	14·00	50·00	31·00
... ...	5·13	8·84	56·14	29·89
arh	2·80	10·30	56·38	30·52
... ...	1·50	13·00	51·00	34·50
langa	4·12	9·42	56·47	29·99
... ...	?	11·00	56·00	33·00*
... ...	2·25	13·00	53·50	31·15
ore	5·25	9·50	51·50	33·75
3 Feet Seam	3·31	12·16	55·84	28·69
.. ..	6·20	13·50	47·50	32·80
15 Feet Seam	4·00	10·50	58·50	27·00
... ...	3·15	22·50	44·50	29·85
raboni	4·00	9·00	59·00	28·00
, 7 Feet Seam	3·00	19·25	46·25	31·50
chia	3·40	15·00	51·20	30·40
... ...	3·60	9·00	54·00	33·40
al or Barakar Series.				
... ...	1·00	14·00	58·50	26·50
d, 12 Feet Seam	?	17·00	55·00	28·00*
di	1·25	17·50	52·00	29·25
... ...	1·25	14·00	61·00	23·75
.. ..	?	11 to 23	64 to 54	20 to 23*
hal, 12 Feet Seam	1·50	16·00	55·00	27·50
8 Feet Seam	0·75	22·05	52·45	24·75
20 Feet Seam	0·50	25·00	49·00	25·50
ERRIA COAL-FIELD.				
al or Raniganj Series.				
eh, A	2·48	11·04	57·24	29·24
A	?	12·50	57·00	30·50*
C	2·29	11·09	54·21	32·41
C	?	17·80	50·70	31·50*

No. of Seam.	Name of Mine and Village.	Hygroscopic Moisture.	Ash.	Fixed Carbon.	Volatile Hydrocarbons.
	JHERRIA COAL-FIELD.—*Continued.*				
	Lower Coal or Barakar Series.				
17	Burragarh	1·75	11·00	62·00	25·25
,,	,,	?	6·00	64·00	30·00*
16	Bhaga	?	10·60	60·40	29·00*
,,	Bulliari	?	9·70	?	?
,,	Burragarh	1·40	14·00	62·00	22·60
,,	,,	?	21·50	?	?
,,	Kunkanee	1·50	24·00	55·00	19·50
,,	Kurkend	?	18·00	?	?
,,	Seejooah	?	10·00	63·00	27·00*
15	Ekra	0·50	15·00	66·00	18·50
,,	Gopalichuck	1·20	14·00	60·00	24·80
,,	Kunkanee	1·25	17·50	64·50	16·75
,,	Kurkend	?	16·00	?	?
,,	,,	?	8·00	?	?
,,	New Kurkend	?	11·00	?	?
,,	Seejooah	?	12·00	62·50	25·50*
,,	Seejooah, 15a	?	12·00	64·00	24·00*
,,	,, 15b	?	11·00	64·00	25·00*
,,	Simlabahal	0·10	11·00	62·00	26·90
14	Bagdigi	1·25	13·00	61·50	24·25
,,	Benahir	1·25	10·00	65·00	23·75
,,	Bhaga	1·30	11·00	69·60	18·10
,,	Kunkanee	0·50	16·00	65·00	18·50
,,	Kusunda	1·50	12·00	69·00	17·50
,,	Suratar	1·65	11·00	63·00	24·35
13a	Bholunbararee	1·00	11·00	65·00	23·00
13	Bagdigi	1·00	16·00	59·00	24·00
,,	Kusunda	0·05	17·00	63·75	19·20
,,	Sooratand	0·85	11·00	69·50	18·65
12	B. O. Coal Co.	1·25	14·00	60·00	24·75
,,	Ekra	?	14·00	68·00	18·00*
,,	Godhur	0·25	13·00	66·50	20·25
,,	Kantapahari	?	10·00	67·00	23·00*
,,	Lodna	0·75	15·50	65·50	18·25
,,	Nayadee	0·00	21·00	59·00	20·00
11	Kantapahari	0·75	12·00	68·25	19·00
,,	Madhuban	0·75	18·00	56·25	25·00
10	Dobari	0·50	22·60	60·40	17·00
,,	Fatehpur	?	11·00	67·50	21·50*
,,	Godhur	0·25	18·00	68·50	13·25
,,	Kantapahari	?	10·00	67·00	23·00*
,,	Nayadee	0·25	23·00	56·75	20·00
,,	,,	?	14·50	67·50	18·00*
9 & 8	,,	?	16·50	65·00	18·50*
7	Chandore	0·25	18·00	66·00	16·00
,,	Garia	?	14·60	63·15	22·25*
,,	Golukdeeh, lower 15 feet	?	16·00	60·30	23·70*
,,	Goonadeeh	?	22·50	59·60	18·50*
,,	Pandedih	?	20·00	62·00	18·00*
	GIRIDIH COAL-FIELD.				
	Lower Coal Series.				
	Upper Seam	?	11·96	60·46	28·11*
	Lower Seam	?	9·15	66·84	24·42*

* Including hygroscopic moisture.

NOTE.—A number of analyses of Indian Coal are given by Prof. Wyndham R. Dunstan, in his paper on "The Coal-resources of India, and their Development," *Journal of the Society of Arts*, 1902, vol. l., page 371.

APPENDIX D.—Consumption of Coal in India for the Years 1880, 1890, 1900 and 1903.

Years.	1880.	1890.	1900.	1903.
	Tons.	Tons.	Tons.	Tons.
Imports into India of Coal, Coke and Briquette-fuel ...	729,058	817,004	142,467	192,729
Output of Coal in India ...	1,019,793	2,168,521	6,118,692	7,375,110
Totals	1,748,851	2,985,525	6,261,159	7,567,839
Less: Exports of Coal ...	53	26,649	542,953	441,949
Consumption of Coal in India	1,748,798	2,958,876	5,718,206	7,125,890

Mr. J. S. Martin (H.M. Inspector of Mines, Bristol) said that Mr. Stonier had described the roof in some of the mines as of very strong rock. It would have been interesting if Mr. Stonier had told the members what was the effect of the breaking of the roof, whether large areas fell, and whether the coal was much crushed or not. He had heard that in one of the coal-mines of Hyderabad, India, a very large crush took place a few years ago, and a number of men were unable to get clear of it. He (Mr. Martin) did not know whether this district was known to Mr. Stonier, but if the circumstances were similar he thought that it would be interesting to know about it. The accident had created quite a panic among the natives, and it was only with great difficulty that the officials could induce the men to return to their work in the mine.

Prof. Henry Louis (Newcastle-upon-Tyne) thought that Mr. Stonier's paper was possibly misleading in one respect, as he had not pointed out that the working of pillars was the exception and not the rule in any of the Indian coal-fields. He had formed the opinion, during a visit made last year, that from 15 to 25 per cent. of the coal was being absolutely wasted. He did not think that Mr. Stonier had mentioned a pillar larger than 60 feet square, and he (Prof. Louis) did not remember having seen any exceeding 100 to 120 feet square. It was quite evident that pillars of this size were too small for the proper working of the pillars afterwards; and, almost without exception, he had noticed that the pillars that were left were cracking and breaking away

he corners owing to their being made too small to withstand roof-pressure.

Mr. C. CHETWYND ELLISON (Barnsley) asked what was the ercentage of round coal obtained.

Mr. F. L. G. SIMPSON (Mohpani Mines, India) wrote that the pillar-working methods at Khooldia appeared to be rendered possible solely by the abnormally good roof which prevailed. It would be exceedingly interesting, however, to have a few photographs shewing the condition of things existing, whilst the dropped coal was being filled. The changing of the 7 feet props for 14 feet props in the wide work must also be a somewhat interesting operation. The absence of danger from overhanging coal was a great advantage, and with a capital roof the above system seemed the safest way to work the seam at Khooldia colliery. It was not stated what thickness of sandstone occurred in the main roof, which was a very important matter.

At the Sodepore colliery, the roof, next the seam, appeared to be bad, and the changing of the short props in the wide work seemed to be somewhat risky. Here, again, it was not stated what thickness of sandstone occurred in the main roof.

At the Borrea colliery, a great deal of the No. 3 seam appeared to be left. The system of working the No. 4 seam appeared to involve the loss of a lot of the coal. The system of working the No. 5 seam was not described.

At the Bhaga colliery, the 16 feet of shale seemed to form a roof under which no one could safely be sent to fill up the fallen top coal, and the system of working did not appear to compare favourably with a system of lifts of moderate width, each lift to be drawn out as soon as finished. A great deal of coal seemed to be lost in the top coal and stooks, as such a roof as that described would apparently not allow the stooks to be very much thinner.

Mr. P. G. VICKERS (Bengal, India) wrote, with regard to the method of pillar-extraction at Khoira colliery (Jherria coal-field), that since Mr. Stonier visited this colliery in March last, a new district to the dip had been opened out for the extraction of pillars. This district was being worked from the full dip to the rise, and had about 200 feet of cover. The method of taking out the pillars was rather different from that which Mr.

Stonier had seen, inasmuch as the pillars were taken out from the dip, parallel to the strike, or nearly so, instead of parallel to the dip. This had been found to work well, the weight coming on at more regular intervals. The system of splitting the pillars in halves and quarters, and working the stooks near the goaf first, was still adhered to. The subsidence from these workings at present, had been from 3 to 5 feet, over an area of about nine bigahs extracted. Occasionally it had been found possible to remove a whole pillar, but this depended entirely upon the manner in which the weight acted, and required very careful watching by the sirdars in charge of the shift. After the first subsidence had taken place, the roof came down in sections as the pillars were taken out, filling up the goaf to the last line of stooks near the goaf. Mr. Stonier had said that when there were signs of weighting, small ribs or knobs of coal were left against the goaf-edge. When this occurred, it was found safer and more economical to leave these ribs or knobs, and to draw the timber at once. The timbers were *sal*, usually 14 to 17 feet long, and about 5½ inches in diameter, costing about 1s. 2d. (14 annas) each. Very little timber was lost in these operations.

Mr. Thomas Adamson (Giridih, Bengal, India) wrote that Mr. Stonier, in his notes on the Giridih (Karharbari) coal-field, stated that the output was derived from the lower seam, which was 12 to 30 feet thick. Three seams were being worked in this coal-field, namely, the lower, the upper and the hill seam. The thickness of the lower seam varied from 8 feet to 22 feet, and the depth of the Jubilee pit (the deepest coal-raising shaft in India) was 653 feet.

It would be interesting to know what area was dropped, when the stooks were blasted out, in dropping the 2 feet of band-stone and 5 feet of top coal at Khooldia. The recovery of the stooks, 8 feet square, with 2 feet of stone lying on them, must be a difficult and expensive operation. If the stone could be removed before the recovery of the stooks, the system would be improved if 5 or 6 feet of the coal next the floor were worked in the first operation, and the rest of the seam including the band of stone were dropped, as was done at the adjoining Karharbari and Serampore collieries of the East Indian Railway Company.* There would be a considerable saving in getting the coal, as

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 10.

2d. (2 annas) only was paid for loading dropped coal, and 4d. (4 annas) for hewing it. The timbering, with props spaced 30 feet apart, in his opinion, was insufficient, and *chowkidars* (stooks) when spaced 200 feet apart would not serve any useful purpose.

The second system, described as being in force at Khoolda colliery, was the old system practised in Bengal. The disadvantages of this system were:—(1) More slack was made; (2) the timber had to be renewed as each lift was taken; and (3) the roof was exposed for a longer time than when the coal was dropped before the coal was all loaded out.

In the third system, described as being in operation at Sodepore colliery, ribs, 4 or 5 feet thick, were left in a seam 17 feet high. These could serve no useful purpose, and must be a source of danger to the people working close by them.

Mr. Stonier stated that at Borrea colliery packing was done, being the only case in Bengal. Packing had been used, and was still being built, in working the upper seam, 7 feet thick with 2 feet of sandstone in it, at the East Indian Railway Company's Karharbari colliery, Giridih. Packing was resorted to in this case to support the surface, on which were mines, houses, and paddy-land (rice-fields). All the coal was worked. When the roof settled down on the packs, the surface subsided a few inches only; the surface-cracks were then repaired, and practically no damage was done to the houses and land.

Mr. R. R. Simpson (Geological Survey of India, Calcutta) wrote that in the introduction to Mr. Stonier's paper it was stated that the Gondwana beds were conveniently divided into an Upper Coal Series (or Raniganj of Dr. W. T. Blanford) and a Lower Coal Series (or Barakar of Dr. W. T. Blanford). It was to be presumed that the Gondwana coal-bearing beds were meant; but to prevent misconception, it might be stated that, as recognized by the Geological Survey of India, the Gondwana system had two divisions, the lower of which, in Bengal, could be subdivided into three series, of which the middle one—the Damuda series—was again split up into three stages, namely, the Raniganj stage, the Ironstone Shale stage, and the Barakar stage. The substitution of such colourless and even misleading terms as Upper and Lower Coal series for the well-known names of the Raniganj and Barakar stages was a practice which could not be too strongly deprecated.

Mr. E. Seymour Wood (Seaham Harbour) wrote that he had read with interest Mr. Stonier's paper, in which he described the system of working out the pillars at Khooldia colliery, Giridih, in the Karharbari coal-field, and at Sodepore colliery, in the Raniganj coal-field. Both these collieries were under his (Mr. Wood's) charge for 8 years.

At Khooldia colliery, the main roof, a thick and strong sandstone, was a very safe one; when the goaf gave indication (it gave plenty of warning) that it was about to fall, the miners were withdrawn from the district weighting; and, when the area was a large one, from the mine altogether, as in some cases the "air-blast" was strong enough to do great damage in the mine, blowing out stoppings, breaking tubs, destroying the shaft-timbering, and even the shaft and surface-headgear. The yield from the systems described was found to be very satisfactory, very little coal being lost, where the pillars taken out had been left of a sufficient size in the first working; small pillars, which had been left for some time, were "overridden" and crushed under big goaf-falls. The timbering was set by a gang of native timber-men; and all props were drawn by the same men under the personal supervision of the European assistant in charge of the pit. The miners in this field were the best class working in the coal-fields, and had been used to broken working for many years.

At Sodepore colliery in the Raniganj coal-field, when broken working was commenced in No. 3 pit and No. 1 incline, it was found, as had also been the experience at the Sanctoria collieries, that the local miners were afraid of and did not like pillar-cutting. Several methods were tried, to induce them to take to the work; eventually it was found advisable to draft the local miners into galleries at the new pits opening out, and to import labour from Giridih and outside villages to work the broken mine. The third system was found to give the best results in yield and safety. The whole of the coal was removed as far as possible, for any accumulation of coal and dust left in the mines was a source of danger, as the coals in this field were liable to spontaneous combustion. Underground fires had occurred at the Sanctoria, Barmondhia, Kalipahari and Raniganj collieries.

The Chairman (Mr. James C. Cadman) moved a vote of thanks to Mr. Stonier for his interesting paper.

Mr. M. Walton Brown seconded the resolution, which was ied unanimously.

Mr. G. A. Stonier, in replying to the vote of thanks, said at the accident at Hyderabad had been investigated by Mr. rundy, who had reported on the matter, and the Government ere at the present moment considering his report.

The pillars in Bengal, although in some cases they were not as large as those to which people were accustomed in England, were sufficient for the purpose. There had been no serious trouble in Bengal. The pillars were as much as 110 feet wide, and occasionally a little larger than that, and as the dip and cover were small there was not much weight upon the pillars. This paper describes the successful working of small pillars; and waste seems inseparable from coal-winning and consumption.

Detailed sections of the seams in the Giridih coal-field were given in Dr. Walter Saise's paper on "The Giridih (Karharbari) Coal-field."* A small quantity of coal was won from other seams, but the output was dependent, at the present time, on the working of the lower seam. The contents of all the seams that would be worth working had been included in the estimate of the life of the coal-field. The thickness of the sandstone above the main seam was variable, but at Khooldia, it was, believed, about 30 feet.

The use of packing was exceptional in Bengal; but it was being used, at the time of writing his paper, for the support of a railway-line. In the past, small areas in other coal-fields, where bungalows were located, had also been packed.

At Sodepore, 72 per cent. of the produce was round coal; and, at Giridih, the percentage was very high, because a large tonnage of coal was dropped.

The terms Upper and Lower Coal Series, generally used on the coal-field, are self-explanatory, and do not place any tax on the memory.

Mr. E. H. Roberton's paper on "The Problem of Dynam Balance" was read as follows:—

* *Memoirs of the Geological Survey of India*, 1894, vol. xxvii., page 86.

THE PROBLEM OF DYNAMIC BALANCE.

By E. H. ROBERTON.

For some time past, the problem of the dynamic balance of .e winding-engine has occupied the writer's attention, a problem ›nstituting no inconsiderable portion of the wider and more ›mprehensive question of deep winding.

The various mechanical and economic details connected with ıe extraction of minerals from great depths are being day-by-ıy brought into prominence through the gradual exhaustion ſ the more superficial deposits. The probability of the extensive ɾploitation in the near future of the deep Coal-measures of the ſidland district of Great Britain, the extent and resources ſ which may prove of vast magnitude and importance, renders ıis investigation especially interesting and valuable to the ıining engineer of the Midlands, as on the suitability of his inding-plant to perform economically and efficiently the work lotted to it may depend the success or failure of the whole heme. The solution thus constitutes a vital issue in deep-ılliery practice, in which heavy loads must be raised with ıormous speed, and with a minimum risk of accident, in order maintain the large output necessitated by the great cost of ıaking deep shafts, and of a modern colliery-equipment. For ıis last reason, too, the increase in size and power has been ıt of all proportion to the increase in depth from which the ıgine winds, and threatens to render it too cumbersome and un-ieldy for the quality of work required from it.

Increase of output combines with increase in depth to im-›se on the capacity of the winding-engine a tax, which is at ıe commencement of the wind far in excess of the average power ›quired over the whole period of winding, and very much further ı excess of the power required towards the latter portion of the ind, before the brakes are applied. The whole operation of

winding divides itself into three natural periods, the periods of (*a*) acceleration, (*b*) constant speed, and (*c*) retardation, though in pits of moderate depth the middle period is often non-existent. The increase in depth, then, and the greater masses to be accelerated (load, cages, chains, ropes, pulleys and drum), as well as the increase in acceleration to ensure a sufficient rapidity of winding, involve a vastly augmented demand for power from the engine at the beginning of the trip. It is a practice much in favour to effect this result by the use of a pair of compound engines, which are constructed so that at the commencement of the wind the high-pressure steam may be turned into the low pressure cylinder, and the high-pressure cylinder exhausted into the atmosphere, the engines being run expansively after the maximum speed is attained. The chief aim of the engineer being the creation of a high velocity in a short period of time, leaving the rest of the trip practically to take care of itself, the engine is therefore built with a view of creating a fairly large acceleration at the outset, and left to do work during the greater part of the wind (especially if the ropes are unbalanced), which is far below its capacity; indeed at the end of the trip it is often called upon to assist the brakes in destroying the stored-up energy supplied by itself to the moving masses.

A serious consequence of the employment of a large engine of this type, with its intermittent demand for short bursts of power, is the effect on the boiler-plant, which must be of more than ample capacity, in order to supply large periodic quantities of steam with brief intervening spaces of comparative inactivity. In a mine of considerable depth, the winding-engine will be of such a size that, unless there be an adequate boiler-plant to admit of the withdrawal of large quantities of steam periodically, without too much temporary loss of pressure, other engines depending on the same boilers for their supply of steam will suffer. The want of economy caused by the expenditure of capital upon a battery of boilers of comparatively abnormal capacity, is exaggerated whenever the engine ceases winding temporarily (to enable repairs to be carried out in the shaft, or for some other reason), by the excessive loss of steam from the safety-valves.

This waste from the boilers due to the stopping of the winding-engine should be included in an accurate computation of the

steam-consumption. This, combined with the fact that numerous other engines are often dependent on the same boiler-plant for their steam-supply, introduces so many complications that an estimate with any approach to accuracy is almost impossible.

The results of recent experiments on winding-engines given by Dr. H. Hoffmann* are of great interest, as a guide to the work done by winding-engines under different conditions. The comparison between the ordinary drum winding-engine and a Kœpe sheave winding-engine is well illustrated in Figs. 1 and 2 (Plate XIX.), the net load in both cases being 9,480 pounds raised from a depth of 1,430 feet. It will be noticed that the Kœpe system holds the advantage, in that smaller engines are used, and full steam is kept up in the cylinders during a greater proportion of the wind than in the case of the drum winder. Fig. 3 (Plate XIX.) is the speed diagram of the Kœpe winder; the initial acceleration being about 3 foot-second units, and there being a period of about 12 seconds of approximately constant (though slightly increasing) speed. In Fig. 1 (Plate XIX.), the back-pressure steam used at the end of the trip to assist the brakes in retarding the masses in motion is well shewn, while in both Figs. 1 and 2 the want of uniformity of power demanded of the engines and the desirability of some means of attaining or approaching this uniformity are obvious.

In order to ensure the uniformity of steam-demand, details of a scheme of double-stage winding were formulated in 1884 by Mr. Joseph Hrabak, Pzribram, Bohemia, and afterwards laid before the Paris International Mining Congress of 1900.† By this method, the winding was to be conducted from the bottom to a stage in the shaft, and thence by a second operation to the surface. Both winding-engines were to be placed at the surface, and operated alternately, tapered ropes being employed for the lower stage.

The disadvantages of this method, however, probably outweigh the advantages to be gained by the reduction in the cost and wear-and-tear of plant. Off-setting of sections of the shaft is ren-

* "Untersuchungen an Dampffördermaschinen," *Zeitschrift des Vereines deutscher Ingenieure*, 1904, vol. xlviii., page 149.

† "Conditions d'Exploitation à Grande Profondeur," by Mr. Joseph Hrabak, *Bulletin de la Société de l'Industrie Minérale*, 1900, vol. xiv., page 135.

dered necessary, and the lower stage winding-rope must be guided down the shaft and into the working section by means of pulleys, thus adding to the inertia of the masses to be accelerated, as well as increasing the risk of accident. The services of an additional winding-engineman are required, besides attendants in the shaft for changing the load.

A modification of this method has been suggested, by which the winding is carried out in two or more stages, and the engine for each stage placed in the shaft at the top of its own stage; power being conveyed to it down the shaft.

A method of stage winding that is more desirable, for reasons of economy in working, and for cheapness in first cost, is that by which one winding-engine only is employed, however many stages there may be. An attendant is required at each stage to work the signals. The distances between the stages are equal, and each cage is hung by a rope from the bottom of the cage above it, and travels only between its own stages. Offsetting of sections of the shaft is therefore unnecessary, and the changing of the tubs at the intermediate stages might be done automatically by means of hydraulic rams.

This scheme, which in theory may be extended to any number of stages, is shewn in the double stage in Figs. 4, 5 and 6 (Plate XIX.). In the first position (Fig. 4), the cage, A, is at the top of the shaft, and has just exchanged its full tubs for empty ones; while the cage, D, has just received a load of full tubs at the bottom of the shaft. In the middle of the shaft, the cage, B, has discharged its full tubs into the siding, while the cage, C, has changed its empty tubs for full ones, previously discharged from the cage, D. At the completion of the wind, the cages take the second position (Fig. 5), in which the empty tubs from the cage, A, are transferred into the siding or shaft-chamber, and the full tubs, previously in the cage, B, take their place; while the full ones from both cages, C and D, are exchanged for empty ones. Thus the full tubs are constantly ascending, and the empty ones constantly descending, but never leaving their own side of the shaft; that is, tubs from cages A or B are not transferred to cages C or D.

The above-described method of stage winding obviously does not demand a constant supply of steam from the boilers, as do

methods by which independent stage winding-engines are ated in rotation. A little consideration will shew, however, in winding from considerable depth, it possesses an advant- over single-stage winding, in that it tends to equalize the ɜr-demand during the period of winding. Assuming the contained in each cage in double-stage winding to be the ɜ as that in single-stage, the time occupied in winding to re a similar output would also be the same. But the dis- e through which the cages are drawn is only one-half. It lear, therefore, that the speed of winding can be much ced, the average speed for double-stage winding being half hat requisite for single-stage. It is true that the masses ɜ set in motion are considerably greater, but this is set-off by fact that more time can be afforded to the engines for the leration period. The acceleration itself is also much modi- since the maximum speed is not so great as in the single- e method. Again, there is in the shaft at the commencement winding a length of rope on the empty side, which partly ıterbalances the weight of the winding-rope on the full side. :he case of the extension of this system to more than two es, the proportion of this partial counterbalance becomes ıter, the acceleration required for the moving masses and maximum speed are still further diminished, though the dead ses of drum, ropes and cages are increased.

[t may easily be conceived, then, that (in theory at any rate) difference between the work done by the winding-engine ing the acceleration period, and the average work required ɑ it for the entire trip, may by this means be diminished.

[n order to verify this proposition, the writer has, for the ı of comparison, made a rough investigation of single-, ɔle- and quadruple-stage winding, from a depth of 4,000 ; the output being taken at about 100 tons per hour in each . Ropes of plough-steel with a tensile strength of 210,000 ıds are supposed to be used, and the factor of safety for the s that are subjected to bending round the pulleys and drum ken as 8, while for the other ropes it is taken as 6, being cal- ted from the static load.

t should be remembered that, during the acceleration period, actor of safety becomes virtually reduced, the reduction being

very considerable in the case of high acceleration. For instance, if the acceleration be $4\frac{1}{2}$ foot-second units, the tension of the rope is increased above the static tension according to the equation: —

$$T - mg = 4\tfrac{1}{2}m.$$

T being the acceleration tension; m, the mass of the loaded cage, and g the acceleration due to gravity. Thus the increase in tension is in the ratio of $36\frac{1}{2}$ to 32, or about 8 to 7, and the virtual factor of safety is reduced in the ratio of 7 to 8.

With regard to the work done in the acceleration period, the average unbalanced load and the average acceleration are taken as fundamental data; these, although not giving absolutely accurate results, being deemed sufficient for the end in view, seeing that the examples are merely comparative.

The drums, in the calculations immediately following, are taken to be of the cylindrical type, which is of value in allowing the full rope to coil in the grooves that the empty rope has previously occupied, thus reducing the width of the drum. For the single-stage wind, therefore, using a drum, $22\frac{1}{2}$ feet in diameter, and taking the greatest diameter of the winding-rope (calculated below as made up of varying sections) to be $1\frac{5}{8}$ inches, a width of about 9 feet of drum is required, to allow of the accommodation of the rope. The weight of such a drum would be about 50 tons.

The moments of inertia of the drum and pulleys are, for facility of working, reduced to their equivalent rim-masses, this latter quantity depending on the ratio of the radius of gyration of the drum or pulley to its full radius. The ratio of the equivalent rim-mass to the total mass, therefore, varies with the build of the drum or pulley, but may be taken generally as rather more than one-half.

Each cage is taken as weighing 7,000 pounds, and carrying four tubs each of 825 pounds tare, and 1,650 pounds net load.

Single-stage Method.—In the case of the single-lift method, let the acceleration and retardation be $4\frac{1}{2}$ and 5 foot-second units respectively, and the constant speed, 63 feet per second.

Let t_1, t_2 and t_3, represent the periods of acceleration, constant speed and retardation respectively; and s_1, s_2 and s_3, the corresponding distances traversed.

$$\text{Then, } t_1 = \frac{63}{4\frac{1}{2}} = 14 \text{ seconds,}$$

$$s_1 = 14 \times 14 \times \frac{9}{4} = 441 \text{ feet.}$$

Similarly, $t_3 = 12\frac{3}{4}$ seconds, and

$s_3 = 397$ feet.

Therefore, $s_2 = 3{,}162$ feet, and

$t_2 = 50\frac{1}{4}$ seconds.

Therefore, the total time of motion is 77 seconds. Or the total time of winding and loading, is, say, 100 seconds. This gives an output of 106 tons per hour.

Next, with regard to the masses accelerated:—

Suppose the rope to be made in four sections of 1,000 feet each, the first section weighs 2,550 pounds; the second, 2,900 pounds; the third, 3,350 pounds; the fourth, 3,850 pounds; the mass of the extra rope, 1,120 pounds; and the total mass of each rope is 13,770 pounds.

The equivalent rim-mass of the drum, is, say, 60,000 pounds: the equivalent rim-mass of two pulleys, 12,000 pounds; the mass of two ropes, 27,540 pounds; the mass of two cages, 14,000 pounds; the mass of eight tubs, 6,600 pounds; the mass of the live-load, 6,600 pounds; and the total mass accelerated is 126,740 pounds.

The kinetic energy at the end of 14 seconds is $126{,}740/64 \times 63^2$ or 7,859,860 foot-pounds.

The average unbalanced weight of 21,220 pounds raised 441 feet represents 9,358,020 foot-pounds. Therefore, the total work done in the first 14 seconds is 17,217,880 foot-pounds, the equivalent of 2,236 effective horsepower.

To compare this with the horsepower required over the motion period of 77 seconds:

The work due to the live-load raised 4,000 feet is 26,400,000 foot-pounds; the work done in producing acceleration, 7,859,860 foot-pounds; and the total of 34,259,860 foot-pounds, the equivalent of 809 effective horsepower.

If taken over the whole winding period of 100 seconds, the average effective horsepower is 623.

Double-stage Method.—Considering next the double-stage method: the rope is in four sections, the first section weighs

1,800 pounds; the second, 2,000 pounds; the third, 5,570 pounds; the fourth, 6,430 pounds; the mass of the extra rope, 1,500 pounds; and the total mass of each rope is 17,300 pounds.

The width of the drum, as the actual wind is 2,000 feet, would be rather under 6 feet, and allowing for additional strength required owing to the heavier weights involved, would probably be about the same weight as the drum in the last case.

The equivalent rim-mass of the drum is, say, 60,000 pounds; the equivalent mass of two pulleys, 15,000 pounds; the mass of two ropes, 34,600 pounds; the mass of four cages, 28,000 pounds; the mass of sixteen tubs, 13,200 pounds; the mass of the live load, 13,200 pounds; and the total mass accelerated is 164,000 pounds.

To ensure an output similar to that of the last case, suppose the constant speed to be 32 feet per second, and the acceleration and retardation to be 2 and 3 foot-second units respectively.

Then, $t_1 = 16$ seconds, and
$s_1 = 256$ feet.
Similarly, $t_3 = 11$ seconds, and
$s_3 = 181$ feet.
Therefore, $s_2 = 1{,}563$ feet, and
$t_2 = 49$ seconds.

Therefore, the total time for winding is 76 seconds, which gives about the same output, namely, 106 tons per hour.

In the first 16 seconds, the work due to lifting the unbalanced load is $24{,}270 \times 256$, or 6,213,120 foot-pounds. The kinetic energy due to motion is $2{,}562 \times 1{,}024$, or 2,623,488 foot-pounds. Therefore, the total work done in the first 16 seconds is 8,836,608 foot-pounds, which is equivalent to 1,004 effective horsepower. Taking the work done over the whole period of motion, the work done in lifting the load is 26,400,000 foot-pounds; the work done in producing acceleration, 2,623,488 foot-pounds; and the total of 29,023,488 foot-pounds represents 695 effective horse-power. Or, if taken over the whole period of winding and changing loads (100 seconds), it represents 528 effective horse-power.

Quadruple-stage Method.—In the quadruple-stage system, the acceleration and retardation are assumed to be 1 and $1\frac{1}{2}$ foot-second units respectively, and the constant speed as 16 feet per second.

Then, $t_1 = 16$ seconds, and
$s_1 = 128$ feet.
Similarly, $t_3 = 10\frac{2}{3}$ seconds, and
$s_3 = 86$ feet.
Therefore, $s_2 = 786$ feet, and
$t_2 = 49$ seconds.

Therefore, the total time of winding is 76 seconds, which gives approximately the same output of 106 tons per hour.

As the acceleration is so small, the factor of safety is taken as 7 for the top rope, and as 5 for the others.

The masses of the ropes then will be: first rope, 1,490 pounds; second rope, 3,100 pounds; third rope, 4,900 pounds; fourth rope, 9,900 pounds; the mass of the extra rope, 2,000 pounds; and the total mass of each rope is 21,390 pounds.

The masses accelerated will be:—Equivalent rim-mass of drums, say, 150,000 pounds; the equivalent rim-mass of two pulleys, 20,000 pounds; the mass of two ropes, 42,780 pounds; the mass of eight cages, 56,000 pounds; the mass of thirty-two tubs, 26,400 pounds; the mass of the live load, 26,400 pounds; and the total mass accelerated is 321,580 pounds.

In the first 16 seconds, the work due to the lifting of the unbalanced load is $35,700 \times 128$, or 4,569,600 foot-pounds.

The kinetic energy is $5,024 \times 256$, or 1,286,144 foot-pounds.

Therefore, the total work done is 5,855,744 foot-pounds, which is equivalent to 665 effective horsepower.

Taking the work done over the whole period of motion of 76 seconds, the work done in lifting live-load is 26,400,000 foot-pounds; the work done in producing acceleration, 1,286,144 foot-pounds; and the total of 27,686,144 foot-pounds is equivalent to 662 effective horsepower. Or, if averaged over the period of 100 seconds for winding and changing loads, it represents 503 effective horsepower.

It will be seen from the foregoing examples that the effect of substituting multiple-stage for single-stage winding is, in general, not so much a reduction of the average horsepower required from the engine (though it does reduce it), as a means of lessening the difference between the power required at the commencement of the wind, and the average power required throughout the wind.

Stress has been laid by many practical men on the advantages to be gained by counterbalancing. This has been practised for many years in mines of moderate depth, the plant of which was laid down before the days of high-pressure steam. The advent of this latter obviated the pressing need for counterbalancing, which went out of use; but the increase in depth of mining, with its greater length of winding-rope, has again brought before engineers the advantages to be gained by its adoption. Methods of balancing that have done, and still do useful work, are the chain-balance, the attachment of a tail-rope beneath the cages, the spiral drum, and one or two other systems that have received a trial, such as the Després and the Camphausen methods. In all cases, however, engineers have merely aimed at countering the weight of the unbalanced winding-rope, and have in many instances stopped short even of this

We have seen the marked discrepancy between the power required from the winding-engine during the acceleration-period, and the average power required throughout the wind. If some means were devised of spreading this great initial power over the whole trip, or in other words, to take the energy which is accumulated in the moving masses at the time of the highest velocity, and apply it at the beginning of the trip, and (of necessity) to apply it negatively at the end, the power required from the engine would be nearly uniform during the greater part of the wind; also the brake-power required to stop the masses in motion would be comparatively small. The solution of this problem should not be beyond the ingenuity of the present-day mining engineer. The economic results would be great, both in the first cost of the engine and boiler-plant, and also in the loss from wear-and-tear.

The most obvious solution that suggests itself is the adoption of overbalancing. In the case of the ordinary winding process, with a cylindrical drum and unbalanced ropes, the position of equilibrium occurs when the full load is somewhere near the top of the shaft, either below it (actual), or above it (virtual), and the greatest static load is at the start. In the case of the balanced rope, there is no position of equilibrium, and the static load is constant throughout the wind. In the case of the overbalanced rope and load, the position of equilibrium wou

when the full load is somewhat below the centre of the shaft;) static load at the commencement would be in favour of the gines, while after passing the position of equilibrium it would against the engines, and constantly increasing.

The Kœpe sheave system of winding could, to a limited :ent, be easily applied to this end, by simply hanging beneath) cages a rope of heavier make than the winding-rope, or :haps two or more ropes instead of one. A great advantage :ainable from this would probably be the complete prevention the slipping of the rope on the sheave (which seems to be the ,in objection to this method of winding), as the slip obviously :es place when the engines, or the brakes, are exerting their ximum of power, therefore the equalizing of the power erted by the engine, and the assistance given to the brakes, ll tend to the entire prevention of slip.

It will be interesting to compare with the results obtained m stage-winding, the effect of substituting a Kœpe sheave the single-stage winding, above described, and a tail-rope of avy build, so as to overbalance the rope and load. To obtain) best theoretical result, the turning moment exerted by the gines should be constant throughout the entire period of nding.

Kœpe Sheave System.—The cages, etc., are assumed to be the ne as before.

Then supposing a tail-rope (or ropes) weighing 16 pounds to) foot to be used, and for the working rope a factor of safety 8, as before, the weight per foot of the working rope will be) pounds.

Thus the masses dealt with are:—Equivalent rim-mass of the ave, 20 feet in diameter, say, 30,000 pounds; the equivalent n-mass of two pulleys, say, 12,000 pounds; the mass of the iving-rope, 45,150 pounds; the mass of the tail-rope, 64,000 unds; the mass of two cages, 14,000 pounds; the mass of eight bs, 6,600 pounds; the mass of the live-load, 6,600 pounds: l the total mass accelerated is 178,350 pounds.

The turning moment in favour of the engine at the beginning the trip is 154,000 foot-pounds; and in favour of the brakes he end of the trip is 286,000 foot-pounds.

The position of equilibrium occurs at a distance of 1,400 feet the bottom of the shaft.

From the overbalancing alone, the initial acceleration gained 492,800/178,350 or 2·75 foot-second units. This of course mediately begins to decrease and reaches *zero* when the full d has ascended 1,400 feet.

The mean acceleration due to overbalance is 1·37 units.

Similarly, the final retardation due to overbalance is 5·3 units, nd the mean retardation is 2·65 units.

It is evident that, in this case, acceleration will take place until the natural retarding force of the overbalance is greater than the force that the engine happens to be exerting at the time. In order that the engine may exert an uniform force throughout the wind, the effective force exerted by the engine should by itself create an acceleration, which is half the difference between the initial acceleration and final retardation due to overbalance. Or in other words the effective turning moment exerted by the engine should be half the difference of the turning moments exerted by the overbalancing arrangement.

In this case, therefore, the acceleration created by the engine would be:—(5·3—2·75)÷2 or 1·27 foot-second units.

The uniform effective turning moment exerted by the engine will be:— 66,000 foot-pounds.

This, applied through 4,000 feet at the end of a 10 feet radius is 26,400,000 foot-pounds.

The time of a wind would be $2\sqrt{2,000 \div 1{\cdot}005}$ or about 8 seconds, and, therefore, the average effective horsepower exerted by the engine throughout the wind would be 565.

The maximum velocity attained in the shaft, given by v, equals $\sqrt{402 \times 2{,}000}$, that is, about 90 feet per second, or rather over 60 miles per hour.

The output would be 98 tons per hour.

Comparing this with the single-stage winding, above referred to, it appears that with 30 per cent. less engine-power exerted over the motion-period, an output is obtained which is diminished by only 7½ per cent. The reason for this is that in the ordinary method a certain proportion of the energy imparted to the moving masses by the engine is destroyed by the brakes and lost, whereas in the overbalance Kœpe sheave system, herein described, the engine exerts an uniform force, which obtains up to the last moment, and just brings the cages to rest, no brake-power being used.

Though there seems no reason why the above operation should not be modified, so as to suit the existing conditions of winding, it would be impracticable to carry it out exactly as described. For instance, if the engine were built of just sufficient size to perform the work accurately, after allowing a reasonable margin for friction, it would not be able, in a case out of the ordinary running, to exert a turning moment sufficient to overcome the greatest moment exerted by the overbalance. This latter is equivalent to 286,000 foot-pounds, while the former, with a liberal allowance for overcoming friction and inertia of reciprocating parts, would be 100,000 foot pounds. It is obvious that with twin cylinders, each cylinder must be capable of exerting by itself the greatest possible turning moment required, that is, in this case about 300,000 foot-pounds. Therefore, if the engine is built so that each cylinder is capable of exerting this maximum moment, the uniform force required during the winding would be roughly one-sixth of what it is capable of exerting. This result could be effected by using the steam expansively, in such a way that the mean effective pressure would be one-sixth of the boiler-pressure. A twin engine of the compound type is therefore eminently suited to deal with this method of winding, being run expansively from beginning to end of the wind under ordinary conditions. In special circumstances, when the greatest turning moment is required, high-pressure steam could be used in the low-pressure cylinder, but this would not be of frequent occurrence; and an additional advantage is the fact that at such times as it is necessary, a high rate of acceleration is not required in the moving parts. The limit of size of the engine is therefore defined by its capability of just overcoming the maximum opposing turning moment. It should be remembered that in the ordinary process of winding the engine is handicapped by the fact that it has at the same time to overcome the maximum turning moment, and to create a high rate of acceleration in the moving masses.

The adaptation of the spiral drum, or of such other methods as lend themselves to overbalancing, would lead to a similar result as the above, the engine being designed so as just to overcome the maximum turning moment, and in ordinary circumstances to run expansively during the whole of the

The spiral drum may be adapted to the method of overbalance in two ways:—

(1) By increasing the ratio of the large to the small diameter, beyond the point necessary to ensure static balance.

(2) In the case of the drum being built for static balance, a tail-rope may be hung beneath the cages. This, even if it were only of light build, would cause overbalance, since it exerts its turning moment at the extremity of the large radius of the drum, both at the beginning and the end of the trip. It must be borne in mind, that in this case, owing to the different radii of the unwinding and the winding sides of the drum, the shaft must extend a good distance below the level from which winding takes place, to allow of the loop of the tail-rope descending to its maximum depth. The amount of overbalance depends on the radii of the drum and the masses of ropes, etc., in use, and should be estimated so as to give the best results for each particular case.

The ideal diagram of moments of such an engine, based on the figures of the above Kœpe example, would be that shewn in Fig. 7 (Plate XIX.). In the example referred to, the brakes are not used, but it is probable that in actual practice the overbalance would not be made quite so great, and the engine would exert a slightly increased force at the start, so as to allow of an appreciable period of nearly constant speed; also the speed would be kept up till nearer the end of the trip, and the brakes utilized to stop the motion. Such a modification would shorten the time of winding, and slightly increase the average moment required from the engine, besides destroying its uniformity. The conditions, however, would be greatly superior to those obtaining in the unbalanced winding-engine, or even in the statically balanced system, owing to the more uniform demand for power.

Any attempt to effect a solution of the problem of dynamic balance which involves the employment of an intermittently running engine, can at best attain only partial success, as it is evident that between the operations of winding uniformity of power-demand is destroyed. The ideal contrivance will attain this end by employing a steadily running engine, and storing the power by some method of accumulation, electrical, hydraulic

r pneumatic; or possibly some combination of a direct wind-
ıg-engine and a power-accumulator.

Of the three forms of power-storage, the hydraulic may be
ismissed, as being for practical reasons unsuitable for the
igh-speed work necessary in deep shafts. The only obvious
ethod of its application, namely, substituting an equivalent
eight of water in the empty cage for the constant turning
oment required by the engine in the overbalanced Kœpe sheave
rangement, above described, or some similar contrivance, fails
ı an emergency, when a greater turning moment is required
ıan can be exerted by the water-weight. The solution of the
oblem of dynamic balance, however, would be perfect in this
ıse, if it were only practicable, as the main pumping-engine
ould deal with all the pit-water at the same time, working
eadily day and night.

It is highly probable that we have not seen the last of the
ıeumatic system of hoisting, invented by Mr. Zulma Blanchet.*
:s advantages in connection with deep shafts are numerous.
he method can be practised with as great facility in mines of
ıormous depth as in shallow mines, and the winding-rope,
hich in a deep mine is a very expensive item, and a constant
rain on the resources of the concern, is entirely dispensed with.
. heavy load can be dealt with at each trip, and the speed of
ıe cage, especially in the descending trip, is almost unlimited.

This system, besides apparently possessing many unique
dvantages for the purposes of deep mining, offers a neat solution
f the problem under consideration. There seems no insuper-
ble reason why the engines should not be kept running steadily
hrough the whole working day. The air in the tube, at the
eginning of the hoist, would be in a higher state of rarefaction
han at the end (when it could be automatically compressed if
ıecessary, to stop the motion of the cage). This seems to suit
he case exactly, as the arrangement exerts the greatest power
ust when it is needed, the power exerted gradually diminish-
ng as the operation of winding progresses.

There remains to be discussed the question of the electrical
ıccumulation of power. Economy in the application of elec-

* *Trans. N.E. Inst.*, 1873, vol. xxiii., page 81 ; and *Bulletin de la Société de l'Industrie Minérale*, second series, 1875, vol. iv., page 557 ; and 1878, vol. vii., page 273.

tricity is best gained by the use of a central generating-plant which does duty in electrifying many large works distributed around it. That this system of power-centralization will be extended to mine-works there is little doubt. Prof. R. A. Redmayne gives as his opinion that the great mining concerns of the future will be supplied with power from a central generating plant, driven by producer-gas engines, and that possibly three or four different mining companies will join forces to build a common generating-plant which shall supply them all. The colliery of the future to which he looks forward is one which, by means of three or four shafts, shall produce a daily output of 12,000 tons: the power required being perhaps 25,000 horse-power. The economy attained by this eminently cheap form of power-generation will be very considerable, it being stated that the virtual consumption of coal in a producer-gas engine is as low as 1 pound per horsepower-hour.

The form of motor used for winding may be of the three-phase type, or of the continuous-current type. A great advantage, whichever form is used, is that the speed at which they run varies extremely little, whatever the load may be, even if there be a negative load. The small variation in the working speed of electric motors at first led to the idea that they could only be run economically at the speed and load for which they were designed, and that therefore for winding purposes, which demand very varied conditions in both speed and load, they would prove unsuitable. But, according to Mr. — Irvine, an electric motor can take not only 50 per cent. overload in starting, but can now also be built to run at 20 per cent. of the full load, without the efficiency falling off more than from 7 to 10 per cent. In these respects, therefore, electric motors compare very favourably with steam-engines.

With regard to the economy gained by the use of electric hoisting machinery, electrical engineers claim that with an up-to-date generating-plant, the coal-consumption is brought down to less than 40 per cent. of its original value. The steam-consumption of electric winding-engines, according to Mr. Paul Habets, varies from 31 to 42 pounds per horsepower-hour *of* useful work.

As the dynamos are continually giving out energy, whether

the motors are running or are at a standstill, the energy generated when the motors are idle is in some cases stored in secondary batteries, to be afterwards used in giving the required motion to the masses of the mineral, cages, etc., a condition which approaches very nearly to the solution of the problem of dynamic balance. This, however, besides being only applicable to continuous-current motors, involves many complications, especially if, as is really necessary, devices for an increased torque at starting are employed. The secondary batteries themselves, too, possess many inherent disadvantages and defects, rendering this system of power-storage impracticable.

This is well exemplified in the case of the engine now in operation at the Zollern II. colliery, and formerly exhibited at the Düsseldorf Exhibition. The expense and complexity of the secondary batteries and switching gear led to the abandonment of this form of storage, and to the adoption of Mr. Carl Ilgner's simpler method of accumulation of energy in a high-speed flywheel. That the inventors have every confidence in this new device is clear, from the fact that winding-engines of a total capacity of 17,000 horsepower were being constructed in the earlier part of this year for various mines, before having been put into practical operation anywhere. A special advantage of this contrivance is that not only can it be used for a continuous-current installation, but also for alternators, provided that each winding-engine has its own generator.

It is said that the kinetic energy stored in one of these flywheels is sufficient in itself to give out power for several trips, in case the main supply should be cut off. At first sight, it seems strange that electricians should fall back on the mechanical idea of flywheel-rotation for the purposes of power-storage, and one is inclined to ask whether this device could not be adapted to steam winding-engines, without the necessity of previously converting the steam-power into electricity.

Mr. W. Galloway (Cardiff) wrote that the first question that occurred to him on reading Mr. Roberton's paper was as to whether there was any pressing necessity for introducing more than one stage of winding for a depth of 4,000 feet, since they knew that one-stage winding, to use Mr. Roberton's expression, was

eady successfully carried on at the Tamarack mines at a greater pth than this. Reduced to their simplest form, Mr. Roberton's guments in favour of winding simultaneously from two or ore stages were:—(1) With one-stage winding from the ssumed depth there is such a sudden great demand for steam hat the boiler-plant must be abnormally large to meet it. (2) The reduction of pressure consequent upon this sudden demand will prejudicially affect the working of all other engines connected with the same boilers. (3) When the engine ceases winding, so as to enable repairs to be done in the shaft, or for any other reason, there will be a great loss of steam through the safety-valves. (4) The greater momentum imparted to the moving masses, on account of the greater velocity (which a one-stage wind involves as compared with a two- or multiple-stage wind), must to some extent be wasted during the period of retardation.

To all of these points the answer was *non sequitur*: (1) A reservoir of steam of the necessary dimensions, kept warm by the hot gases from the boiler-furnaces, would obviate the necessity of having an abnormally large boiler-plant. (2) It was not necessary, but only generally convenient, to connect the boilers producing steam for the winding-engine with the other boilers. (3) The boiler-fires would be banked, in the event of the winding engine ceasing to work. (4) A proper system of balance-rope, such as Mr. Roberton himself had outlined, a system, he (Mr. Galloway) might add, that had often occurred to himself and doubtless to many other engineers, would effectually recover the work done during the period of acceleration. Lastly, the greatest possible velocity in winding had not by any means been attained, and there did not appear to be any mechanical difficulty in the way of doubling the present maximum velocity by the use of more perfect appliances, when occasion arose for doing so, either with the Kœpe pulley or preferably, perhaps, with the cylindrical drum and a balance-rope. Until, therefore, the possibilities of existing systems had been exhausted, or were within sight of exhaustion, it seemed to be somewhat premature to enter upon a serious discussion as to what other system was most likely to replace them.

Mr. Sydney F. Walker (Bath) wrote that the problem was really that of economic winding; and, with increasing depths,

and increasing outputs from individual shafts, the problem became more and more pressing. Stated in its simplest form, the problem was as follows:—The actual work done in lifting a certain amount of coal from a certain depth in a certain time involves the expenditure of energy, at a certain rate, of a certain number of horsepower; this power can be furnished by the consumption of a certain quantity of coal; how near to this theoretical quantity is it possible to come in practice? Thus, taking the figures given by Mr. Roberton in the paper, 100 tons raised per hour from a depth of 4,000 feet, required an expenditure, leaving out all charges for conversions, of 113 horsepower, assuming that the work was actually continuous; and this amount of energy could be obtained by the combustion of 30 pounds of coal per hour, taking the calorific value of coal at 10,000 units per pound, and the mechanical equivalent of heat at 778 foot-pounds, but it was impossible to get anywhere near these quantities in practice. Machinery must be employed, and each machine took toll of the energy delivered to it; but the great object to be attained was the closest approximation to the theoretical quantity. In winding, the waste of power was particularly large, from the following causes:—(1) The heavy condensation-losses, owing to the engine standing between winds, and for long periods during a large part of the day, and to steam being cut off from the engine during a portion of the wind itself. (2) To the fact that, as mentioned by Mr. Roberton, a larger boiler-plant had to be provided, in order to stand the heavy drafts of steam taken by the winding-engine, without unduly lowering the pressure of the steam supplied to other engines on the same service. (3) The fact that the descending rope was continually lengthening, while the ascending rope was continually shortening in each wind. (4) The fact that the descending cage was acquiring more and more momentum as the wind proceeded, while the energy acquired could not be made use of, except by cutting off the supply of steam to the engine. (5) The fact that the work was intermittent, and made up of a number of starts from rest, and a number of stops, in which energy had to be expended in preventing the momentum of the moving masses from doing work that would be harmful.

The Kœpe system, as he understood it, overcame one of these drawbacks by making the length and the weight of the rope

constant throughout the wind, so that energy had only to be expended in overcoming the friction of the two ropes, in this part of the problem; and hence the Kœpe system was more economical and allowed the wind to be performed with a smaller engine than with the ordinary arrangement.

Mr. Roberton's proposed arrangement of stage winding, he understood to consist of dividing the shaft into sections, with twice as many cages as there were sections, the actual lift, each time the engine turned, being only the length of one section. It appeared very doubtful whether that arrangement would really give increased economy. The question of handling the tubs from one cage to the other round the shaft would add considerably to the time taken in the wind and to the cost. In addition to this, it appeared that the work actually done in getting each cage to the surface, apart from that taken up in moving the tubs across the shaft, would be more than in single stage winding. There would be, say, four starts and stops in place of one, in quadruple stage winding; and though Mr. Roberton claimed that a lower acceleration might be given, he (Mr. Walker) hardly thought that would be possible; and as he read the figures, the acceleration would be greater. Would it not be better also, if something of the kind were feasible, to make one change, and adopt the endless chain or rope for the shaft, on the lines suggested by Mr. W. D. Wight, of Gelli, a few years ago? Certain structural alterations to the arrangements of the shaft would be necessary, but if properly carried out it should be the most economical arrangement in point of power consumed.

The great feature of the Siemens-Ilgner electrical system of winding was the fact that all the momenta generated in the different parts of the system, in descending, were stored, and were available to assist during the starting and acceleration period of the next wind. As was explained in Mr. Hird's paper,* the storage could be effected either electrically in accumulators or mechanically in a flywheel, as at present; the mechanical arrangement promised best. There was the remote danger of the flywheel bursting, against the very constant trouble of the sparking attendant on the disconnection of conductors carrying the large currents involved. The system also enabled further economies to be realized, as sketched by Prof. Redmayne. It

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 592.

was more than probable that collieries would drive all their machinery by electric motors, using current delivered from a central station, which might, as Prof. Redmayne suggested, be supplied with energy from gas-producers, or even from the gases of coke-ovens. The central generating station enabled considerable economies to be effected, owing to the fact that advantage could be taken of the load-factor; and wherever there were a number of machines at work, usually only a portion were actually taking power at the same time, so that economy in first outlay and in running costs might be arranged. There would, of course, be no difficulty whatever in adapting electric driving to an endless-chain system for the shaft.

The Chairman (Mr. J. C. Cadman) moved a vote of thanks to Mr. Roberton for his paper.

Mr. M. Walton Brown seconded the resolution, which was cordially approved.

Mr. J. Cresswell-Roscamp's paper on "An Improved Apparatus for Laying Dust in Coal-mines" was read as follows:—

AN IMPROVED APPARATUS FOR LAYING DUST IN COAL-MINES.

By J. CRESSWELL-ROSCAMP.

The dangers impending where coal-dust has accumulated have for some time been recognized as necessitating the utmost attention, and the minds of mining engineers have for so long been occupied in trying to discover a means to overcome these risks, that the writer ventures to think that this notice of a new method or appliance to solve the difficulty, needs no apology, but will be received with approval by the members.

In submitting the following short paper, it is his desire to place on record the information which has been gathered from some satisfactory personal experiments. Experiments, conducted both in this country and abroad, all tend to prove the vital importance of every precaution being taken to render impossible any repetition of the catastrophes resulting from negligence and ignorance of this subject.

It has been proved beyond a doubt that a mixture of coal-dust and atmospheric air may be the means of initiating a violent and destructive colliery-explosion, even in the absence of fire-damp, and, the finer the dust, the more easily will it ignite and become dangerous.

Prof. W. Galloway has said that very little dampness is necessary to prevent coal-dust from igniting, and he has given many instances of explosion in which the flame has stopped when it has come to a part of the road that was only damp, and not wet, as advocated as a necessity by many.

Up to the present time, it appears to be the general opinion that water is the most potent agent in obviating these dangers, and any method by which this element may reach the various parts of the roadway, such as the roof, timbers and vertical surfaces, in order to dampen the dust effectually and thus render it

less, will naturally commend itself to all unprejudiced
s; and, moreover, in the application of this liquid the
r it approaches the condition of aqueous vapour, the greater
ɔe its power, and the more complete its success.

any attempts have been made to water and lay the dust on
oads, sides, and timbers in coal-mines, and methods have
been introduced and brought before the members claiming to
nt the accumulation of the dust. However, no apparatus,
rto devised for this purpose, has been entirely satisfactory
iciency and practice.

ABLE I.—THERMOMETER READINGS BEFORE AND AFTER THE PASSAGE OF THE IMPROVED WATERING TUB.

Thermometer.		Barometer.		Dry-bulb Thermometer.	Wet-bulb Thermometer.	Humidity.	Remarks.
At Bank.	Underground.	At Bank.	Underground.				
Degs. Fahr.	Degs. Fahr.	Inches.	Inches.	Degs. Fahr.	Degs. Fahr.	Percentage.	
53¼	64	29·99	30·67	61	58½	83·4	Raining.
—	—	—	—	60¾	59¼	89·2	Tub passed the hygrometer at 11·35 a.m.
—	—	—	—	60¾	59	88·1	
—	—	—	—	61	58¾	85·4	
57	66	30·06	30·72	61	58½	83·4	Dry and warm.
59	68	29·83	30·46	64½	62	82·4	Dry and warm.
—	—	—	—	64	62¾	91·2	Tub passed the hygrometer at 11·35 a.m.
—	—	—	—	64¼	63	90·5	
—	—	—	—	64¼	63	89·8	
—	—	—	—	64½	62¾	87·3	
—	—	—	—	64½	62¼	84·9	
64	69	29·80	30·44	64½	62	82·4	

ne method, by which this has been effected, is an improved
ing tub,* which, in outward appearance, is similar to an
ary colliery tub. The mechanism is simple, consisting of
small pumps, A, with cylinders 3 inches in diameter by 2
s stroke, and an air-cylinder, B, 7 inches in diameter and
ches high. The pumps are driven direct from one axle, C,
e tub, and connected to three sprayers or nozzles, D, fitted
at either one or all may be used. In this simplicity of
ruction there are several advantages, as no packing is
red, there is no gearing to get out of order, and, in fact,

* British patent, 1903, No. 9,268, Messrs. F. Herbert and P. Kirkup.

whole contrivance is readily handled and easy of access.
action is as follows:—The water (or other liquid carried in the
, E) is forced by the pumps, A, into the air-cylinder, B, which
ises a regular and unpulsating column to flow along the pipes
d out of the nozzles, D. These sprayers or nozzles are fitted with
specially-constructed screw-apparatus round which the liquid is
rced, and which gives the spray a circular momentum reaching
breadth up to 30 feet. The sprays, thus emitted, are in the
shape of inverted cones impinging on each other and becoming
so completely atomized and aerated, that they in reality form a
vapour. This vapour is carried along by the air-current, an
can clearly be felt from 100 to 150 feet behind the tub, when i
is in motion (Figs. 1, 2 and 3, Plate XX.).

TABLE II.—THERMOMETER READINGS BEFORE AND AFTER THE PASSAGE OF THE IMPROVED WATERING TUB (FIG. 4, PLATE XX.).

Time.	Thermometer.		Barometer.		Thermometer in Haulage-road, A.			Thermometer at Coal-face, B.			Remarks.
	At Bank.	Underground.	At Bank.	Underground.	Before.	After.	Difference.	Before.	After.	Difference.	
	Degs. Fahr.	Degs. Fahr.	Inches.	Inches.	Degs. Fahr.	Degs. Fahr.	Degs. Fahr.	Degs. Fahr.	Degs. Fahr.	Degs. Fahr.	
a.m.											Raining.
11·0	56½	66½	29·40	30·56	63½	—	—	63½	—	—	Tub passed thermometer in haulage-road at 11·10 a.m.
11·30	—	—	—	—	—	60½	−3	—	61½	−2	
											Volume of air at face, 1,400 cubic feet per minute.
12·0	—	—	—	—	—	61½	+1	—	61	−½	
12·30	60	67¼	29·38	30·56	—	62½	+1	—	61	−0	

In this way, therefore, the whole surface of the roadway is damped, and as will readily be perceived, the spray, assuming the shape and nature that it does, is able to damp all surfaces approached, both in front and behind. Where water is applied with any force on dust that is thoroughly dry, it runs off with the finer dust in the form of spherules and then becomes a means of raising the dust rather than laying it. The spray being thus atomized, should not have any ill-effects on the roof, floor, or sides of the roads.

The tub will travel and do its work quite as efficiently by any means of haulage, be the system main-and-tail, endless rope or horse; and it is quite as easily moved along by manual labour as any ordinary tub.

The liquid sprayed need not necessarily be water, and lime-water, white-wash, or any other preservative of timber may be ejected in a similar manner.

A tub of ordinary size will contain sufficient liquid to lay the dust over a distance of between 1 and 2 miles of roadway.

A tap, F, is fitted to the pipe connecting the pumps and the nozzles, and when this is turned, the liquid flows back into the tank instead of out of the nozzles, when a spray is not desired.

TABLE III.—TRIALS OF THE IMPROVED WATERING TUB.

No.	Description.	Distance.	Time.	Speed per Hour.	Roadway.				Water Used.	Surface wetted per Gallon of Water used.
					Perimeter.	Surface.	Calculated Surface of Timber, &c.	Total Surface.		
		Feet.	Mins.	Miles.	Feet.	Sq. Feet.	Sq. Feet.	Sq. Feet.	Gallons.	Sq. Feet.
1	Tub drawn by main-and-tail rope.	2,970	3¾	9	35	103,950	31,200	135,150	60·87	2,220
2	Tub drawn by horse.	1,854	8½	2·49	35	64,890	16,656	81,546	44·27	1,842
3	Tub drawn by endless rope.	4,800	13⅔	4	34	163,200	74,400	237,600	110·27	2,154

Tables I., II. and III. contain the results of a few personal experiments, and they fully justify the assertion that the imminently dangerous properties of coal-dust are minimized to an infinitesimal quantity by the treatment herein described.

Mr. G. H. COATES (Hucknall Torkard) wrote that he had had the opportunity of seeing one of the improved watering tubs at work on a dry and dusty roadway, and he considered that it afforded a most efficient and effective method of dealing with this problem. He was further of opinion that such a watering tub would prove invaluable at collieries as a ready means of compliance with the provisions of the Coal-mines Regulation Act relating to the laying of dust on main haulage-roads previous to the firing of shots; and he ventured to think that if a liquid disinfectant were used in place of the water it might materially assist in maintaining the present comparative immunity from ankylostomiasis. He also thought that a saving in costs would be effected, in some cases, as at certain

ieries with which he was acquainted, the annual cost, in our alone, expended in watering the haulage-roads amounted as much as £40, while the working cost of this contrivance, ich could be readily attached to the prevailing method of ulage, and ran unattended, appeared to be practically *nil*.

Mr. A. A. Atkinson (Chief Inspector of Coal-mines, Sydney, ew South Wales) wrote that the question of the treatment of oal-dust in collieries was one which had been engaging the ttention of colliery-owners, mining engineers, managers and inspectors of coal-mines for the past 25 years, and it still remained a subject in regard to which very diverse opinions were held; this divergence being evidenced by the numerous papers on the subject published in the *Transactions* of mining institutions and by the annual and special reports of H.M. inspectors of coal-mines. The only references to coal-dust in Imperial legislation are contained in No. 12 General Rule, of section 49 of the Coal-mines Regulation Act, 1887, and again in section 1 (i) (a) of the Act of 1896, which gives power to propose, amend and modify Special Rules in reference to "the watering or efficient damping of the mine or any ways or places therein." So far as he was aware (having left England in 1897) it did not appear that any Special Rules had been framed in Great Britain, in order to give effect to the power conferred by the above-mentioned portion of the Act of 1896.

Many methods of treating coal-dust, some similar to that described in the paper, had been adopted, as well as others involving considerable expenditure in pipes, etc.; on the other hand, the doubtful benefits of watering long lengths of dusty underground roads, appeared to have given rise to the abandonment of the system in some parts of Great Britain during the last few years.

Having regard, therefore, to the generally admitted importance of the subject, the various opinions held in regard to it, and its present position in the legislature, he ventured to suggest that The Institution of Mining Engineers might appoint a committee to experiment, if thought necessary, and to report on the question. The conclusions embodying the consensus of opinion of such a committee would be generally acceptable to the coal-mining community, and such work, he thought, was peculiarly appropriate to such an Institution.

Great benefits were derived from the report of the Committee of the North of England Institute of Mining and Mechanical Engineers on "Flameless Explosives," published early in 1896.* The conclusions were of great value in framing that part of the Coal-mines Act of 1896 which related to the use of explosives; and he thought that similar benefits might arise from a report in regard to the treatment of coal-dust, if referred to a committee as suggested.

Mr. H. Richardson Hewitt (H.M. Inspector of Mines, Derby) wrote that the improved watering-tub was one of several used for a similar purpose, but it was doubtful whether a spray of water had any beneficial results, seeing that only the upper portion of the dust on a roadway would be wetted. This was not sufficient to reduce the danger unless the dust was frequently stirred up, and as frequently watered by the spraying apparatus. He agreed with Prof. W. Galloway that "very little dampness is necessary to prevent coal-dust from igniting" so long as this dampness permeated the whole of the available dust, and should then approximate to the recommendation of the Prussian Fire-damp Commission, namely, that the coal-dust should take up 30 per cent. of its weight of water.† An apparatus such as that described would do good, so long as it was very frequently used; but from experience he found that dusty roadways were seldom watered, excepting when shots were about to be fired, under circumstances requiring that section 3 of the Explosives in Coal-mines Order should be carried out.

From the experiments made by Mr. Cresswell-Roscamp it appeared that the application of water was best effected by horse-traction, as was expected, seeing that this was the slowest manner of distribution. The humidity-tests shewed from 82·4 to 91·2 per cent. of saturation, which was excellent if this state could be maintained; but the author should give the natural amount of humidity in the mine-air without the watering being done. At the Maybach colliery, Saarbrücken, where a water-pipe installation was at work, the humidity varied from 69 to 92 per cent.; and, when compared with the results obtained before the mine was watered, these figures showed a very inconsiderable difference.‡

* *Report of the Proceedings of the Flameless Explosives Committee*, 1896, by A. C. Kayll.

† *Trans. Inst. M.E.*, 1893, vol. iv., page 660. ‡ *Ibid.*, 1896, vol. x., page 586.

Mr. F. WINKHAUS (Altenessen, Germany) wrote that the apparatus described by Mr. J. Cresswell-Roscamp for the laying of coal-dust in collieries seemed to be of special interest, inasmuch as it turned to profit the action of compressed air in producing a good dust-dispersal with the smallest conceivable waste of water. The apparatus could, doubtless, also be more especially used when it was required merely to damp the main roads. It appeared doubtful, however, whether it would prove equally useful where the dust-emanation took place directly at the working-places and where in consequence its removal was necessary, both there and in the roads leading to them.

In Westphalian mines, such an apparatus would meet with absolutely no success, because the production of coal-dust was to be found principally at the working-places or in the immediate neighbourhood. This was also the reason why the mine-police regulations of the Royal Mine district of Dortmund concerning the wetting of mine-dust in gassy mines, order that hose-pipes be distributed throughout both main-roads and branch roads and shall reach directly to the working-places. All other means (water-tubs, watering-cans, hand-syringes, etc.) appeared unable to cope with the widespread distribution of dust in the mine-workings. Their application was therefore only exceptionally and occasionally allowed by the authorities as a makeshift.* The view taken by the Royal Mining Authority, at least as regards Westphalian conditions, he could but share; for those an apparatus such as that described by Mr. Cresswell-Roscamp might indeed fulfil its object, because in consequence of the hardness of the coal the dust was wont to lie less thickly in the immediate neighbourhood of the working-places than in the roads and airways.

The CHAIRMAN (Mr. J. C. Cadman) proposed a vote of thanks to Mr. Roscamp for his interesting paper.

Mr. M. WALTON BROWN seconded the resolution, which was cordially approved.

Mr. W. T. SAUNDERS' "Notes on the Principal Gold-mining Districts and Mines of Western Australia" were read as follows:—

* *Vide* the confirmation of this Order in *Glückauf*, 1898, vol. xxxiv., page 586.

NOTES ON THE PRINCIPAL GOLD-MINING DISTRICTS AND MINES OF WESTERN AUSTRALIA.

By W. T. SAUNDERS.

Introduction.

The town of Kalgoorlie is the principal gold-mining centre; and the most successful and largest mines are for the most part situated in the vicinity of Boulder, a small township about 3 miles south-east of Kalgoorlie, in the stretch of country known as the "Golden Mile."

In this stretch are three distinct belts of ore, two running parallel (direction: about north 45 degrees west) known respectively as the western belt and the eastern belt, and the third the well-known Oroya chute, which runs at a very easy gradient along a southerly course, ranging in width from a few feet to 00 feet, and in thickness from a few feet to 20 feet, and having n average value of about £1,500 per foot run.

In the eastern belt the most valuable ground lies between e North Kalgurli and Lake View Consols properties inclusive, d in the western belt between the Ivanhoe and Hannans North ar properties inclusive.

The lodes or bodies of ore in both belts are lenticular in m, and can best be described as similar to strings of beans under the other; they are therefore of very varying thicks, ranging from a few feet to 20 feet and more.

The western belt comprizes four and the eastern belt two main es: the formation being diorite.

The principal mines on the western belt are Ivanhoe, Great lder and Golden Horseshoe; on the eastern belt, Lake View sols, Great Boulder Perseverance and North Kalgurli; and the Oroya chute, Brownhill, Associated Northern and the ya Brownhill.

The ore on the western belt is to a certain extent free-milling,

he free-gold contents running about 40 per cent. of the tota
out in the eastern belt and the Oroya chute the gold-values ar
mostly contained in the telluride, and very little free gol
is obtained.

Kalgoorlie, the principal town, is situated about 300 mile
by rail from Fremantle, the port of call for Western Australi
of the different lines of mail and other steamers. It is a fin
modern town, with a population of about 30,000 inhabitants:
it has good up-to-date buildings, electric trams, electric light, etc

The climate in summer is hot and dry, the temperatur
running up to 112° Fahr. and over in the shade. The hea
however, is not particularly oppressive, being dry, and, speakin
generally, the people look well and healthy. In winter, t
climate is said to be perfect. The greatest inconvenience
caused by the dust, and, when there is a high wind, it is ve
unpleasant.

Until recently, the great trouble was the want of water, bo
for mining and other purposes. The water, obtained locally
the shafts, wells, etc., being salt, had to be condensed, a
was consequently a costly item. This trouble, however, has b
removed, and the district is now well and plentifully suppl
with water by a pipe-line from Mundaring, distant about 2
miles.

Mining claims are leased from the Government for 21 yea
and can be surrendered or renewed (practically speaking) at
will. The cost of leasing mining claims is £1 per acre per
annum. One lease must not comprize more than 24 acres, and if
more than this area is required a separate lease for each block of
24 acres or portion thereof must be taken out. No royalties
are demanded until the property becomes profitable, and then
the State exacts 5 per cent. of the profits.

The wages paid in the district per day of 8 hours are as
follows:—Men, working machine-drills, 13s. 4d.; day-miners,
not working drills, 11s. 8d.; and truckers or trammers, 10s. 6d.

For contract-work, the following rates may be taken as a
fair average:—(1) Sinking a vertical shaft, 13 feet by 5 feet,
£7 10s. per foot: the men finding their own "fracture" or
explosives, and the company finding drills, tools, etc., and giving
"clearance," that is, truckers. On this work, the men would make
about £1 per day of 8 hours. (2) Sinking a winze, £3 10s. to

£4 per foot. Cross-cuts, in country-rock, 7 feet high by 5 feet wide, £1 14s. per foot; and on the lode, £1 18s. to £2 per foot. The men find "fracture" and the company, drills, tools and "clearance."

In declaring the monthly crushings, the mines under the management of Messrs. Bewick, Moreing & Company use the ton of 2,000 pounds and all other mines the ton of 2,240 pounds.

Gold-values may prove very misleading, as some mines declare their produce as fine, others as standard, and others as bullion of varying sterling-value. The writer thinks that it would simplify matters if a uniform method were adopted, such as declaring the value of ore-reserves, gold-yield, etc., in sterling: a method usually adopted in America. It is understood that the Government have this matter under consideration, and probably a uniform method of declaring monthly crushings, yield of gold, etc., will be adopted. Fine gold is worth £4 4s. 11d. per ounce.

The former scarcity of water necessitated the mines being very economical in its use, and, for this reason, several dry-crushing plants were installed.

The principal mines crushing wet, in the ordinary way, with stamps, are the Ivanhoe, Lake View Consols, Oroya Brownhill, Golden Horseshoe, etc.; and those using the dry process, the Kalgurli, Associated, Associated Northern, Great Boulder Proprietary, Great Boulder Main Reef and the Great Boulder Perseverance.

Notes on the Mines.

Ivanhoe Mine.—One advantage which the Ivanhoe has over most of the big Kalgoorlie mines is the possession of rich and comparatively free-milling ore. The gold is therefore more easily recoverable and at a lower cost than is the case with some of the neighbouring mines. In days gone by, when most of the mining engineers on the field were puzzling their brains how to overcome the sulphide problem, and were busily engaged in designing plants to obtain a good extraction out of the refractory ore, the Ivanhoe management was handling a fairly large tonnage and, remaining content with a moderate extraction, was paying regular dividends at a time when most of the leading Golden Mile properties were spending immense sums of money on treatment-plants, which for the most part turned out failures and have since been dismantled.

At the commencement of this year, the Ivanhoe main shaft had been sunk to a depth of 2,000 feet: the lodes being developed to a depth of 1,014 feet. The reserves are estimated at about 420,000 tons of ore, of an average milling-value of 21 pennyweights: sufficient to keep the mill running for over three years. Up to the end of November, 1903, the Ivanhoe mine had distributed £923,750 in dividends and had produced gold to the value of about £2,400,000. The monthly crushing now averages about 12,000 tons, and the bullion is valued at about £47,000.

The ore from the mine is broken in Gates crushers to pass through a ring, 2 inches in diameter, before going to the mill, which comprizes 100 heads of stamps (1,200 pounds), running 96 blows per minute with a drop of 8 inches. The mercury in the stamp-boxes and the amalgamating-plates catch the free gold, and the pulp is then concentrated on Wilfley tables.

The concentrates are roasted in Edwards furnaces, put into large vats, and steeped in potassium-cyanide solution for about ten days, and the liquid is then drawn off. The residue is transferred (in order thoroughly to mix it up) to another similar vat and treated again with potassium-cyanide solution in a similar manner; it is then pressed in a filter-press so as thoroughly to extract all liquid carrying gold, and is finally deposited on the dump or waste-heap.

The slimes from the Wilfley tables are treated in the same manner, except that they are not roasted and that they are placed in agitating vats, that is, vats with a mechanical stirring appliance, which keeps the fine slimes in motion and enables the potassium-cyanide solution to act on the various fine particles.

The solution from the vats, carrying the dissolved gold, is then run to the zinc-boxes, consisting of a number of wooden troughs, divided into ten or more compartments, each compartment being about 20 inches long, 12 inches wide and 20 inches deep. The trough, being sufficiently inclined, causes the solution to run through it slowly. Each compartment contains a perforated iron tray of about $\frac{1}{4}$ inch mesh, supported in the first compartment near the top of the trough; in the second compartment, near the bottom; and in the third compartment, near the top; and so on. By this arrangement, the solution passes in a downward direction through the perforated tray in the first compartment, in an upward direction in the next, and so on. The per-

rated trays are filled with zinc-shavings, and when the cyanide lution or the bromo-cyanide solution (used with some of the ore refractory ores) carrying the gold and base metals comes to contact with the zinc, the gold, silver, copper, etc., are pre-ɔitated in the form of slime, which falls through the perfora-ɔns in the tray, and is collected from the bottom of the trough.

The gold-slime is placed in a wooden vat, and treated with solution of sulphuric acid (3 parts water to 1 of acid) : the purpose of dissolving out the zinc. When this is effected, e liquid is drawn off with a syphon or (a better plan) pumped rough a filter-press, which catches any fine slimes.

The gold-slime is dried in a furnace at a dull-red heat, any lphur, arsenic, etc., which may be present being driven off; and y mercury, which may have found its way from the battery the zinc-boxes, is volatilized and may be caught (if a closed rnace is used) by means of a small condenser.

When thoroughly roasted, the slime is fluxed with borax d bi-carbonate of soda, and smelted in a crucible in an dinary Cornish fire. To give the gold a good colour, a ry small quantity of nitre is sometimes mixed with the ıx, or it can be used in the form of solution before the first asting of the ore. The buttons, thus obtained, are smelted and -smelted until they attain the required standard, and the gold sent from the mines in the form of ingots of bullion containing ld, silver, copper, etc.

Copper is the worst metal found associated with gold, as the tassium-cyanide solution attacks it preferentially, using up s strength. This is a considerable item of expense in gold-traction.

The strength of the potassium-cyanide solution, of course, ries according to the ore to be treated. Speaking generally, pound to 2 pounds of potassium cyanide are used per ton of ıff treated. The dressing operations require about 300 gallons water per ton of stuff.

Lake View Consols Mine.—This mine is developed to a depth 1,600 feet on the Perseverance and Consols lodes. The ore-serves estimated at the end of 1903 were:—Blocked out on ree sides, 94,365 tons of ore containing 11 pennyweights; and

blocked out on two sides, 71,860 tons of ore containing 9 penny-weights. The monthly crushing amounts to about 8,000 tons, and the yield is about £18,000. The mine has paid £1,317,500 in dividends.

The ore is broken in crushers, and crushed to pulp in a stamp-mill of 75 heads. The pulp is concentrated on Wilfley tables. The concentrates are roasted in Edwards furnaces, then ground to slime in amalgamating-pans, and finally treated with potassium-cyanide solution in agitating-vats. The liquid is drawn off to zinc-boxes, and the residue, after being filter-pressed, is placed on the waste-heap.

The slimes from the tables are classified: the roughs being reground and treated in the same manner as the concentrates, except that they are not roasted, and bromo salts are added to the solution.

The cost of working is as follows:—Ore-extraction, 1s. 0·564d.; ore-reduction, 19s. 5·631d.; general purposes, 3s. 5·369d.; management, etc., 1s. 2·936d.; the total cost being £1 15s. 2½d. per ton of 2,240 pounds. The extraction is about 88½ to 89 per cent.

Oroya Brownhill Mine.—The Oroya Brownhill mines comprize three distinct holdings (not adjoining one another) and situated on the eastern fringe of the Golden Mile. The rich Oroya chute courses through the Brownhill and the Oroya North holdings; and the Oroya South holding obtains its ore-supplies from the Associated Australian East lode, which is only of medium value.

The cream of the Oroya chute of ore in the Brownhill holding has been exhausted, but in the Oroya North holding there is a large reserve of rich ore developed and opened out in this chute.

The property has large reserves of ore in sight (worth about £2,250,000) and since January, 1904, the working costs have been reduced from £2 3s. 8d. to £1 6s. per ton. The dividends have amounted to £723,741.

The mill comprizes 50 heads of stamps crushing about 7,000 tons per month, and the ore-treatment is practically the same as that in operation at Lake View Consols Mine, Merton roasting-furnaces being used.

lden Horseshoe Mine.—This mine has been opened to a
al depth of 1,100 feet, and possesses three main lodes. It
oduced gold worth £3,000,000, and paid nearly £1,500,000
idends.

e mill comprizes 100 heads of stamps, and an additional
ads are in course of erection. The present crushing is
11,000 per month.

e pulp from the stamps is concentrated on Wilfley tables,
ncentrates are sent in trucks to the port of Fremantle,
they are smelted to lead-bullion, which is despatched to
nd for refining. The slimes are treated at the mine, in
dinary way, with potassium-cyanide solution.

is mine possesses some of the richest gold-bearing ground
lgoorlie, and the ore-reserves blocked out and in sight are
ıted to be worth about £2,000,000.

ılgurli Mine.—This mine has been developed to a depth
50 feet; there are about 5 years' ore-reserves blocked out,
t is highly probable that a fair slice of the rich Oroya
of ore will traverse this property, greatly enhancing its
The mine has paid £90,000 in dividends.

ıe monthly crushing is about 5,500 tons, yielding about
ounces of gold.

ıe ore is broken in a Gates crusher, and is then reduced in
ıll-mills, five of which are working, while one is held in
e. Briefly described, a Krupp ball-mill is a revolving
ler, partly filled with about one ton of hard steel-balls
ıg from 2 to 5 inches in diameter. The ore, fed into the
s reduced to powder by these balls. The crushing is dry,
ter being used; and, if the ore from the mine is wet, it is
in a drier before entering the mills.

e crushed ore from the mills is automatically conveyed
: Edwards roasting-furnaces by means of a screw-conveyer.
'erage time of the roast is 2 hours 40 minutes.

e roasted ore is mixed with water in a mechanical mixer,
assified. The roughs or larger particles are passed over
amating-plates and thence to concentrating-tables; the
ıtrates are then ground in amalgamating-pans and,
er with the slimes from the classifier and tables, are treated
otassium-cyanide solution in agitating-vats: the agitation

these vats being produced by jets of compressed air, blowing through the sludge, and not, as usual, by mechanical revolving arms.

The solution is drawn off to the zinc-boxes in the ordinary manner, and the residue is filter-pressed and dumped or thrown to the waste-heap.

Associated Mine.—This mine possesses several big bodies of ore of average value: the most notable being Tetleys, and the Australian East lodes. It is believed that the Oroya chute traverses this property.

The dry-crushing is effected in Krupp ball-mills: the treatment-plant being similar to that in use at Kalgurli mine. The monthly crushing is at present about 5,500 tons, yielding about 7,500 ounces of gold. The plant is being enlarged, and it is anticipated that the crushing will be increased from 8,500 to 11,000 tons per month.

Associated Northern Mine.—This mine has drawn its ore-supplies from the Oroya chute, which is now practically exhausted, hardly 35,000 tons of ore, valued at 24 pennyweights, from this chute remaining to be treated. Development is proceeding at various points; but, down to a depth of 1,050 feet, there have been no rich finds. The mine has paid £262,500 in dividends.

The dry-crushing is effected in Krupp ball-mills: the mill-capacity being about 70 tons per day.

Great Boulder Proprietary Mine.—The shaft of this mine was 1,900 feet deep at the end of 1903. The lode in the 1,750 feet level is returning 30 pennyweights per ton of ore, from a width of 30 feet; and this augurs well for the future developments in depth of this mine. There are large and rich ore-reserves in sight, blocked out and valued at about £1,500,000.

Since the middle of 1895, the Great Boulder mine has paid £1,550,550 in dividends and about £3,500,000 worth of gold has been extracted from the mine, equivalent to about 3 tons of gold for every 100 feet of sinking.

The ore is crushed in a big Gates crusher, then sorted in a ordinary revolving screen, which rejects everything that w

pass through a ring 1½ inches in diameter. The smalls s direct on a carrying belt to Griffin mills, and the rejections nother Gates crusher where they are reduced to the required e before going to the mills. There are twelve Griffin lls, each dealing with about 30 tons per day: ten being able of dealing with the output. The crushing is dry, and s essential that any wet ore should be dried, before treatment, lriers erected for that purpose.

All the finely-reduced ore n the mills is automatically eyed to twelve Edwards six Merton roasting-fur-es. An Edwards furnace ts about 17 tons, and a ton furnace about 40 tons day. The roasting occupies t 1½ hours.

The roasted ore is mixed water and ground to slime amalgamating-pans, then ted with potassium-cyanide tion in agitating-vats, and r-pressed in the ordinary way. Fig. 1 is a sketch-plan of the ngement of the milling and ssing plant.

The crushing averages from 0 to 10,000 tons per month.

No. 5 Gates Ore-breaker.
Trommel.
No. 3 Gates Ore-breaker.
Drier. Ore-bin.
Feeders.
Griffin Mills.
Gas-producer. Conveyor. Dust-chamber.
Furnaces.
Conveyor.
Elevator.
Mixers.
Pans.
Settlers.
Pump.
Spitzlütte.
Spitzkasten.
Agitation Vats.
Compressed Air.
Filter Presses.
Zinc Boxes.

FIG. 1.—SKETCH-PLAN OF MILLING AND DRESSING PLANT AT THE GREAT BOULDER PROPRIETARY MINE.

Great Boulder Main Reef Mine.—This was a rich mine down a depth of 600 or 800 feet; but, below that depth to 1,300 feet, present depth-development has not been rewarded with any h finds. At one time, the output of gold was 2,000 ounces 2,000 tons crushed monthly, but now for 2,000 tons crushed nly returns about 920 ounces per month. The mine has paid 0,000 in dividends.

The dry-crushing is effected by a plant consisting of Krupp -mills and Edwards roasting-furnaces.

Great Boulder Perseverance Mine.—This mine has been referred to as the richest block of 24 acres in Western Australia. Up to the end of last year, it had yielded over £2,500,000 worth of gold, and had paid in dividends a little less than £750,000.

The monthly crushing averages from 10,000 to 11,000 tons, yielding about 14,460 ounces of gold and 2,280 ounces of silver, valued at about £61,000.

The main shaft is sunk to a depth of about 1,200 feet. The principal bodies of ore are the Perseverance and Lake View Consols lodes, and both formations have been proved payable for a width of about 40 feet in each.

The dry-crushing plant comprizes Griffin mills and Holt roasting-furnaces.

The cost of ore-reduction is about 17s. 11d. per ton.

Notes.

The amalgamating-pan, mentioned in the foregoing notes, is an ordinary grinding pan, a certain amount of mercury being added with the stuff to be ground. The free gold and the mercury form an amalgam.

Amalgamating-plates are so placed in front of the stamp-boxes that the pulp passes over them. The plates are made of copper, and dressed with a surface of mercury: the copper has an affinity for mercury, and the mercury an affinity for free gold. The mercury containing the gold, that is, the amalgam, is scraped off from time to time, and the mercury is volatilized in a furnace, the gold being left. The mercury is caught by means of a condenser.

The filter-presses are machines into which all residues from the cyaniding-vats are placed. The residue, placed between canvas-sheets, is washed, pressed, and compressed air is forced through it. All the liquid drawn off is sent to the zinc-boxes, where any gold that it may contain is precipitated. The canvas-sheet filters the liquid, and prevents any of the residue, etc., from passing with the liquid to the zinc-boxes.

There is very little mining now in the Coolgardie district, the old mining centre of Western Australia. The two largest mines are Burbanks Birthday Gift, crushing about 2,500 tons, and yielding about 1,016 ounces of gold monthly; and the West

ralia and East Extension, crushing about 2,236 tons, and ing about 2,275 ounces of gold monthly.

ı the Kookyne district, the Cosmopolitan is the principal , crushing about 8,000 tons, and yielding about 6,000 ounces ld monthly.

ı the Mount Morgan district, the West Australia mine es about 7,220 tons for 5,500 ounces of gold monthly.

here are numerous mines scattered all over the known gold-ng fields of Western Australia. The Sons of Gwalia mine e Leonora district, crushes monthly about 7,700 tons for d-yield of about 5,300 ounces; it is sunk to a depth of t 1,500 feet on the underlie. The Great Fingall Con-ıted mine, in the Daydawn district, crushes about 8,000 per month, the gold-yield is about 10,850 ounces, and the ends amount to £406,250.

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r. Henry Wright (Kanowna) wrote that the gold-fields, ally speaking, were about 1,800 feet above sea-level. There no streams of water whatever on the surface, with a very rainfall, and a high temperature; these were factors which ıe most part accounted for the dryness of the atmosphere. ıe country was volcanic, and the fissures and ledges of erous rock lay perpendicular or at slight angles from the ndicular, it could easily be understood that whatever rain-here was, immediately flowed into subterranean channels. water took up the salts from the surrounding rocks, such rite, the hornblendic rocks and granite, and became more . In the early days, this water was distilled before it it for use for domestic or steam-purposes, and cost the mer from 6d. to 1s. per gallon. The same method of pro-ʒ fresh water was still pursued in places not yet served by olgardie water-scheme.

ıe Coolgardie water-scheme comprized the Mundaring oir on the Darling range of mountains, about 50 miles the port of Fremantle. From the weir at Mundaring to orlie, the distance was 351 miles. The works were opened bruary 7, 1903. The total cost was then £2,662,000, and ıpplementary works for distribution of the water had cost 720. The total monthly consumption during the past year

had been as follows:—1903, July, 11,936,000 gallons; August, 14,287,000 gallons; September, 17,148,000 gallons; October, 26,440,000 gallons; November, 29,289,000 gallons; December, 31,995,000 gallons. 1904, January, 37,886,000 gallons; February, 40,606,000 gallons; March, 41,724,000 gallons; April, 39,172,000 gallons; May, 37,544,000 gallons; June, 33,067,000 gallons. The average daily consumption, in a[l] channels, since January of this year, when the reticulation w[as] almost wholly completed, was therefore 1,263,000 gallons a da[y]. The scale of charges per 1,000 gallons was as follows:—At Mu[n]daring, 3s. 6d.; Northam Municipal Council, 4s. 3½d.; ordina[ry] consumers between Mundaring and Cunderdin, 5s.; ordina[ry] consumers between Cunderdin and Southern Cross, inclusi[ve], 6s.; ordinary consumers between Southern Cross and Kalgoorl[ie], 7s.; Southern Cross Council, 6s.; supplies to rated services [in] Coolgardie, Kalgoorlie, Boulder, Bonnievale and Burbanks, [3]s. (excess 7s. 6d. and 7s.); ordinary unconditional mining suppl[ies] (Coolgardie and Kalgoorlie districts), 7s.; Mines Trust, spec[ial] agreement for 3 years with daily guarantee of half a milli[on], 5s.; mines using scheme-water for all purposes on the same pr[in]ciple as the Mines Trust, 5s. 3d.; supplies to public bodies [for] parks, gardens, etc., 5s.; supplies to public bodies for swimmi[ng] baths, 5s.; supplies to municipal councils at Kalgoorlie, Boulder and Coolgardie, 6s.; supplies for sluicing purposes, in cases approved by the Mines Department, 3s. 6d.; Kanowna town-supplies, 10s.; Kanowna unconditional mining services, 10s.; Kanowna mines using scheme-water for all purposes, 7s. 6d. The financial results of the year ending June 30, 1904, were:—Revenue, £104,835; expenses, £42,865; gross profit, £61,970. The sources of this revenue were:—Railways, £21,300 9s. 11d.: Kalgoorlie and Boulder mines, £51,131 18s. 4d.; Coolgardie, Bonnievale and Burbanks mines, £2,642 4s. 4d.; Kanowna mines, a few services fixed in June, 1904, £36 2s. 11d.; Southern Cross mines, £1,516 1s. 8d. General services: Kalgoorlie, £15,165 3s. 5d.; Boulder, £7,076 19s. 11d.; Coolgardie, Burbanks and Bonnievale, £3,853 8s.; Kanowna, £36 3s. 3d.; Southern Cross, £251 0s. 1d.; Northam, £679 12s. 8d.; country districts west of Bulla-bulling, £63 12s. 8d.; sundries, £332 9s. 3d. Total, £104,835 6s. 11d. The items of expenditure were as follows:—Pumping expenses, £17,399; maintenance

pipe-track, £8,645; reservoirs and general-maintenance penses, £3,971; water-distribution and management, £6,916; ndries, £1,525; interest and sinking fund on debentures for pplementary construction, £4,410. Total, £42,866. The pros- ctive consumption for the present year was 1,500,000 gallons r day, from which a revenue would be derived of £135,000, a working expenditure of £45,000, leaving a profit of £90,000, ore than covering the interest on the capital and providing a king fund on debentures issued for supplementary works.

The belt of auriferous rocks in the Kalgoorlie district might st be described as mica-schist, hornblendic schist, with diorite d felsite largely in the country-rock. All these rocks were ry much decomposed near the surface. The lodes and ledges re true fissures, and consisted of schists, as before-mentioned, th small veins (very irregular in character) of white quartz ermixed. In the decomposed ledges, that was, near the rface, the ore was free-milling; the sulphide zone lay below e surface from 60 to 300 feet.

Kalgoorlie is famous for the pockets and veins of rich ore, led telluride of gold, found in the mines on the Golden Mile. ese veins, pockets and pipes of telluride of gold appear to e been introduced subsequent to the deposition of the mineral s. Compression may have puckered and formed channels, ch have been dissolved into cavities by underground waters; metallic ores being introduced by infiltration. These ets, pipes or veins of telluride-ore are inclined at various es from the vertical, and in some cases are practically cal. The pipes of telluride-ore are erratic, and may be on oot-wall or hanging-wall, or in the middle of a lode, 40 feet and the gold-contents, after deducting the telluride-ore, not exceed 10 dwts. per ton. It is now the aim to work 10 dwts. ore at a profit, and this can only be done by treat- arge quantities per day, which is now being done success- by most of the mines on the Golden Mile.

he pyritous-mineral veins, as they approach the surface of round, are usually decomposed, and form what is known idized ore. The gold is then in its raw state or free mill- and can be separated from the crushed ore by simple amal- ation only. This is the character of the ore on most of the s outside Kalgoorlie, even where the ore is worked to great

Kalgoorlie is unique in having so many large mines in so small a compass, but mining is actively pursued at other centres as the following statistics for the year ending December 31st 1903, will shew:—East Coolgardie or Kalgoorlie and district 1,275,627 ounces; and other gold-fields, 1,059,798 ounces. The Golden Mile has been developed almost to its utmost capacity and the other gold-fields are very largely worked by proprietors with small capital or by local associations of working miners. The men employed aboveground to produce the above quantities of precious metal numbered 7,980, and underground 9,349, total of 17,329.

Kalgoorlie, the business centre for East Coolgardie, is 3[illegible] miles by rail from Fremantle. It contains about 14,0[illegible] inhabitants and is connected to Boulder City, the workme[illegible] centre, by an overhead electric tram and rail. Boulder City h[illegible] 16,000 inhabitants. Both places have their Mayor and Corpo[illegible]tion, town-hall, race-courses, etc.

The Golden Horseshoe mine has now 150 heads of stam[illegible] running, and treats 15,000 tons of ore per month contain[illegible] 17,000 ounces of gold. This in itself is extraordinary, as a mechanical and chemical process.

Mr. H. F. Bulman (Burnopfield) wrote that it was satisfactory to note that the gold-mines, near Kalgoorlie, on the famous Golden Mile, as they increased in depth, were more than maintaining their output. At the time of his visit in October, 1898, just 6 years ago, the lowest depth then explored at any of these mines was 500 feet, and fears were expressed that the gold-bearing nature of the ground might not continue at lower depths. Now, as Mr. Saunders mentioned, one shaft of the Great Boulder Proprietary mine had reached a depth of over 1,900 feet, and at the 1,750 feet level, ore had been found carrying 30 dwts. of gold to the ton for a width of 30 feet. Again, at the Lake View Consols mine, telluride-ore had been found at the 1,600 feet level, the assay-value of a section of 88 feet averaging 21 dwts. per ton; and at the 1,200 feet level, values of 38 dwts. per ton had been found. This showed that high-grade ore existed in the lower levels, but whether in such large bodies as in the higher levels seemed to be doubtful. The general character of the ground remained much the same, barren regions alternating with

lenticular masses of gold-bearing rock, but at some of the mines the barren patches formed a larger proportion of the whole than they did higher up.

The yield of gold for 1902, over the whole district, per ton of ore milled, according to the Report of the Department of Mines of Western Australia, was 1·31 ounces. This showed the general high-grade character of the ore, but at some of the mines the average yield was much less than this. At one of the best known mines, the average production over last year was only 9·96 dwts. per ton treated, but with economical working this was sufficient to leave a profit. The total output for 1902 of the East Coolgardie gold-field was 1,118,616 ounces, an increase of 12·8 per cent. on the previous year's yield; and the total output of Western Australia for the same year was 1,871,037 ounces.

The Oroya Brownhill mine was given as an example of the satisfactory reduction in working cost which had been achieved. The Lake View Consols mine might be quoted as another case in point, where, during the last 4 years, the working cost had been reduced from £2 10s. 7d. to £1 5s. 6d. per ton of 2,000 pounds; and this was due not to any reduction in wages, which remained much the same, but to the adoption of more economical methods of working. The lower cost allowed of the profitable working of ore of a much lower grade than formerly.

The misleading nature of the returns, to which Mr. Saunders referred, owing to the use of both the short ton of 2,000 pounds, and the long ton of 2,240 pounds, and to fine gold valued at £4 4s. 11d. per ounce as well as the ounce of standard fineness of a lower value, was unfortunate. The Chamber of Mines of Western Australia, in their monthly reports, used the ton of 2,000 pounds, and the value of an ounce of fine gold at £4 4s. 11d.; and most of the mines were likely to conform to this. Perhaps it was to be regretted that the ton of 2,240 pounds, to which we were more accustomed, had not been adopted, but certainly some uniform method was desirable.

The Chairman (Mr. J. C. Cadman) moved a vote of thanks to Mr. Saunders for his interesting paper.

Mr. M. Walton Brown seconded the resolution, which was cordially approved.

DISCUSSION OF MR. G. A. GREENER'S PAPER ON "THE COAL-FIELDS OF THE FARÖE ISLANDS."*

Mr. J. POSTLETHWAITE (Keswick) wrote that the coal-fields of the Faröe Islands appeared to be unique in some of its features. In the eight sections of strata† recorded in Mr. Greener's paper, consisting chiefly of alternating layers of clay and coal, there were two only of shale, measuring respectively 1 inch and 2 inches in thickness, and none of sandstone, grit or limestone (which formed the principal part of the coal-measures in other localities), the clays being, in all probability, the product of disintegrated volcanic ashes and dust similar to that which fell on St. Vincent and adjoining islands during the eruptions which occurred at La Soufrière and Mont Pelé in the West Indies in September, 1902. It might be supposed that after the great outflow of lava, which everywhere formed the base of the coal-formation in the Faröe Islands, periods of activity occurred at long intervals, when vast showers of dust and ashes fell, which, under the climatic conditions then prevailing, rapidly became fruitful soil and produced a luxuriant vegetation, this course of events being repeated until a succession of beds of clay and coal were piled up to the depth of somewhere near 180 feet, after which the whole was again buried beneath immense sheets of lava. This again might have been succeeded by other beds of clay and coal. The anthracitic condition of a considerable portion of the coal in the Faröe coal-field indicated that it was formed at an early period in the world's history. The Faröe Islands had no doubt suffered extensive denudation, and it was probable that a considerable portion of the coal-formation, as it once existed, had been eroded and swept away. In the remote past, it was probable not only that the 23 islands were united, but that they formed part of an extensive land-surface, which was perhaps, at one time, connected with Iceland on the north-west and with the extensive submerged plateau on the south-west, where the rocky islet called Rockall stood, as a silent monument, indicating the position of a once vast, but vanished, continent. A large river flowed through that continent and discharged its waters and their burden of sediment into the ocean, near what is now the western coast of

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 331.

† *Ibid.*, page 334.

Britain, but which at that time was a moderately deep sea. This river formed an extensive delta, portions of which could be traced from the north-western margin of the basin of the Tweed, in Scotland, to St. David's, in the south-western extremity of Wales, in the English Lake District, in the Isle of Man, and in the North of Ireland. It was in process of formation in the far distant past, just at the dawn of life, when *Olenellus*, the trilobite, was lord of creation, and when other forms of living organisms were few; but their siliceous and calcareous shells or cases were preserved in the mud of the ancient river, and thus some of the records of the far distant past had been revealed to the present generation. The deposition of deltaic materials continued throughout the Cambrian, Ordovician and Silurian ages; then that portion of the earth's surface appears to have been depressed, and the old continent disappeared beneath the surface of the ocean. Rockall, the last remnant of this continent, was an isolated granitic mass, about 75 feet high and 300 feet in circumference at the water-line, with a dyke or reef jutting out from it to a distance of 4 miles. It was situated at 57 degrees 38 minutes north latitude and 10 degrees 30 minutes west longitude, and was about 180 miles distant from St. Kilda in the Hebrides. There was an area around the rock, about 100 miles in length and 30 miles in width, where the depth of water was less than 600 feet, but the whole of the Rockall bank measured 280 miles in length and 100 miles in width, and the greatest depth did not exceed 1,200 feet. Outside this area, there was a still larger area, measuring 480 miles in length and 220 miles in width, where the soundings varied from 3,000 to 6,000 feet. Rockall was no doubt the core of an ancient volcano, and was probably connected with the great centre of volcanic activity in the Faröe Islands.

Mr. G. J. Binns (Duffield) said that Mr. Greener appeared to have lost sight of a paper written by Mr. A. H. Stokes.* Prof. H. Louis might refer to a published description of a supposed coal-field among the volcanic rocks of Mihiwaka, near Dunedin, New Zealand, which he (Mr. Binns) examined in 1886.† The discovery at that time consisted of small coal-seams,

* "Notes on the Coal-seam and Geology of Suderöe," *Transactions of the Midland Counties Institution of Engineers*, 1874, vol. ii., page 320.

† "Geology of Dunedin," by Mr. G. J. Binns, *Picturesque Dunedin*, 1890, pages 81-82.

2 to 3 inches thick, and a seam of carbonaceous shale, 2 feet thick, interstratified with tufaceous volcanic rocks of supposed Miocene age. He was of opinion that the deposit was valueless, and he should have grave doubts as to the economic value of the deposits described in Mr. Greener's paper, except under very exceptional conditions. Indeed, the description of the unreliable nature of the seam, as well as the analyses, bore out this view.

DISCUSSION OF MR. A. F. EOLL'S PAPER ON "THE HAMMER-FENNEL TACHYMETER-THEODOLITE."*

Mr. Henry Davis (Derby) wrote that an expert in surveying must be filled with admiration for the inventor of this technical instrument, which was constructed on mathematical principles of the highest calibre, with a view to the saving of time in measuring distance and inclination. He doubted, however, whether the same degree of accuracy was obtainable by the extra-optical system, provided within the tube of the telescope, for reading distances and altitudes as in ordinary practice with the transit-theodolite, steel-band measuring-tape, and ordinary horizontal and vertical circles reading minutely. He considered that the extra-optical system inserted within the telescope would have the effect of preventing the light from illuminating the subtense-hairs. He also thought that the level on the telescope and the striding level were too short, as the accuracy of a survey was dependent upon the accuracy and sensitiveness of these levels. Subtense-surveys were much more frequently employed by the German and the American surveyor than by the British surveyor, and it occurred to him (Mr. Davis) that the tachymeter-theodolite under consideration had not at present gone beyond the technical school in which this instrument had been evolved. Although Mr. Eoll predicted that it would be largely used in the future, it would probably not be employed until the pupils educated in its use had themselves entered into the practical field.

Mr. Adolphus F. Eoll wrote that a slight practical acquaintance with a tachymeter-theodolite would speedily dispel the doubts expressed by Mr. Davis, except, perhaps, that referring to

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 373.

ccuracy of distances obtained by tacheometer-readings as ared with direct measurements by a steel-tape. But the did certainly not more apply to general tacheometry (or -measuring: *celerimensura*, as the Italians say): and what districts that could not well be traversed with the tape? garded the sensitiveness of the levels, he (Mr. Eoll) would Mr. Davis to his paper,* and add that the striding-level ot require to be especially sensitive—indeed, adjustments be attained even without it. He would like to emphasize he tachymeter-theodolite was intended for general tacheo- where an inaccuracy of ± 0·2 per cent. for distances and r 3 inches for altitudes within a range of about 1,000 feet be allowed. The tachymeter-theodolite was, therefore, eable for most technical-topographical surveys, and for aphical and military topography, in open country. As com- with various other tacheometers, a high relative accuracy aintained in spite of the greatly increased facility of work. ished, in conclusion, to add that students of the Technical rsity, Stuttgart, were not the first to make use of the tachy- -theodolite, and certainly would not be the last.

USSION OF MR. SYDNEY F. WALKER'S PAPER ON "THE REPORT OF THE DEPARTMENTAL OMMITTEE ON THE USE OF ELECTRICITY IN MINES."†

r. William Maurice (Nottingham) said that he was glad to Ir. Walker endorsing the general opinion that the *Report of epartmental Committee on the Use of Electricity in Mines* f great practical value. The Committee were to be heartily atulated upon having aroused so much criticism of their ns, since it was only in this way that an accurate estimate e difficulties of the situation could be made. Every eer who was at all intimate with the details of electric g practice knew that the rules proposed by the Committee susceptible of improvement, because some of them could ossibly be adhered to, while others constituted in them-

Trans. Inst. M.E., 1904, vol. xxvii., page 375.
Ibid., page 388.

lves distinct sources of danger. Mr. Walker had endeavoured o boil down, as it were, the Committee's 115 rules into 6, without eliminating anything essential to safety; and in this he had almost succeeded.

The first Special Rule proposed certain pressure limits, but he (Mr. Maurice) must confess his inability to appreciate the necessity for any pressure limit. The pressure should, as Mr. Walker was perfectly aware, be determined by economic and technical considerations and local conditions. It might well be that the best pressure in nearly all British instances of underground transmission would fall within the prescribed limits; but if there was no indication of a tendency to exceed, say, the 3,000 volts limit, and noting, further, that this or any other limiting figure was entirely arbitrary, why go to the trouble of making a rule about it?

The second Special Rule recommended general earthing of the non-conductive metallic parts of every installation; it might be noted, however, that Mr. Walker did not agree as to the advisability of a rigid adherence to the rule. He rightly said that, in many cases, earthing was open to grave objections. A hard-and-fast rule would undoubtedly be productive of much damage to plant in some mines; and, obviously, anything which conduced to deterioration or breakdowns constituted a source of danger. An academic opinion upon the question of earthing was not worth a moment's consideration, unless the adviser was familiar with the pathology (if he might so express it) of cables laid in mines.

The third Special Rule was quite another matter, and had no connection with the question of "earthing," to which reference had just been made. He (Mr. Maurice) agreed with Mr. Walker as to the general inadvisability of employing an earth return, though he did not so easily see the necessity for the rule. A number of cables, with bare returns, had no doubt been laid in mines, but he questioned whether this practice was still appreciably in vogue.

The fourth Special Rule was of a very different order, it was an all-embracing one, and embodied practically everything that counted in the preservation of life and property from dangers arising out of the use of electricity in mines. It seemed entirely sufficient to ensure that maximum of safety which they

agers of mines, desired not less earnestly than those who eking to assist them.

agreed with Mr. Walker (fifth Special Rule) as to the nce of the practice of systematic testing, but joined issue im as to the practical value of making the work com- y. Let the members consider for a moment how such a ould, in practice, be carried out: a testing set consisting small portable generator and a megohm-meter would ly be obtained. To make a test, a few wires would be ted, a handle turned and the resultant meter indications

It was all very simple, and anybody could make the ut a comparison of the results obtained by an expert or with those obtained by "anybody" would probably ome doubt as to the reliability of insulation-records. His Maurice's) impression was that every large plant was tested atter of ordinary routine; but where an installation was ll that an enginewright or fitter could reasonably be con- l to perform the duties of a "competent person," then was merely a waste of time, because the results would nvey any particular meaning. Mr. Walker was, he (Mr. e) felt sure, as well aware as anyone of the impossibility rying on a mining installation within the leakage-limit he specified.

(Mr. Maurice) ventured to think that the sixth Special was superfluous; where was the installation which was ready so controlled? As to the sub-section bearing on e of electrical apparatus in those portions of mines where General Rule applied, he (Mr. Maurice) was at variance he ideas therein indicated. It would appear that certain precautions must be taken wherever the rule applied. w of the perfectly clear statement in the Coal-mines ation Act, it might perhaps seem absurd to ask the n: "Where does No. 8 General Rule apply?" Would t of safety-lamps being used in a mine or part of a mine d to constitute evidence of compliance with this rule? the obvious alternative was to "advance backward" and ndles. The special proposals seemed to have their origin bare fact that a certain kind of electric spark might, certain conditions, ignite a certain explosive mixture of

He (Mr. Maurice) had made experiments and had read

many papers on the subject, mostly in French and German te[ch]nical publications, but he was, so far, unable to discover [such] evidence as might reasonably justify the alarmist view wh[ich] appeared to find most favour in this country. The applicat[ion] of electrical energy in an atmosphere known to be explosi[ve] would demand extremely careful consideration, quite apart fro[m] any statutory or other rules. But, as regarded the vast majori[ty] of coal-mines, he thought that an undue extension of these pr[e]cautionary measures was likely, not merely to do no good, but [to] cause actual harm. The extended use of gas-and-flame-tig[ht] switch-boxes and fuse-boxes, for instance, was not without di[s]advantages. Unless a switch-box was frequently ventilated [it] was quite possible for an explosive mixture to be produced b[y] the decomposition of the insulating materials within the bo[x] itself. Motors, too, should be well ventilated, because th[e] abnormal heating of totally-enclosed machines was one of th[e] most frequent causes of breakdown. If some such rules a[s] those suggested by Mr. Walker, or the rules of the Department[al] Committee in a greatly modified form, were laid before th[e] mining community in the desirable and practical form of safet[y] recommendations, he was convinced that the objects of th[e] Departmental Committee, which presumably was that of increa[s]ing the safety of coal-mining, would be satisfactorily attaine[d].

DISCUSSION OF MR. ROSLYN HOLIDAY'S PAPER O[N] "A COMPARISON OF THREE-PHASE AND CO[N]TINUOUS CURRENTS FOR MINING PURPOSES."

Mr. PHILIP KIRKUP (Birtley) wrote that Mr. Holiday w[as] evidently strongly biased in favour of the three-phase syste[m], so much so as to lose sight completely of the many advanta[ges] of the direct-current method. It was suggested that three-pha[se] motors up to 30 horsepower could be started without the use [of] resistances; but, while this was possible, it would, he (Mr. Kirkup) submitted, be very bad practice to do it systematical[ly]. The forms of starters also for this current were much more co[st]ly and complicated than those used in the direct-current syste[m], which generally took the form of step-up transformers when the line pressure was high, and rotor-resistances when the line

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 410.

assure was low. He (Mr. Kirkup) failed to find, at the Colliery hibition in London, in 1904, a three-phase motor applied to ve different machines for mining purposes without some such m of starter.

The General Electric Company showed a 3 horsepower induc-n-motor with a step-up transformer; the Diamond Coal-ter Company's three-phase motors, two of 12 horsepower, l rotor-resistances; a Hurd coal-cutter three-phase motor l a step-up transformer; and the makers of the two latter chines, he (Mr. Kirkup) felt sure, would not guarantee their cient working without some form of gradual starter. At the ldford Exhibition also, the smallest of the three-phase motors, m ½ horsepower upwards, had starters. It would be inter-ing if Mr. Holiday would give the names of firms who made tors of 30 horsepower without starters, in order that the mbers might make enquiries into the matter. He (Mr. kup) imagined that to reverse the current would create a gerous action, as even from a mechanical point of view, strain on the machine would produce an enormous tension the insulation. As Mr. Holiday remarked, the speed of yphase motors could not be varied except by the use of com-cated mechanism, and here he (Mr. Kirkup) would like to ntion that it was desirable if not essential where electric wind-s was in use to adopt continuous-current motors. If the stem was three-phase, rotary converters were needed, which re heavy in first cost, and complicated what would otherwise a very simple system. Of course, three-phase motors were ed for winding; but these had only two speeds, and even then separate motor was used for each speed: their use was not at l popular, and the control was somewhat imperfect.

With regard to Mr. Holiday's method of placing the fuses at nk, he (Mr. Kirkup) failed to see any useful purpose in this, for the fuses never reached a blow-out current in ordinary work, ey were at least a safe-guard against contingencies of this kind. rther, fuses placed at bank, would, on a fuse blowing, instantly op the whole of the electrical supply to the mine, unless parate cables were provided for each circuit, a costly method. ction I., Rule 5 (*a*), 4 and (*b*) 2, of the proposed Special Rules r the Installation and Use of Electricity in Mines provided at all circuits should be protected by an efficient fuse, and ith this suggestion he (Mr. Kirkup) agreed.

here the pressure is high, the three-phase system h s
tinct advantage over low-pressure continuous curren s,
ially for long-distance transmission: but, when employed t
pressures in general use at collieries (500 to 750 volts), t e
nse in mains exceeds that of continuous-current main ;
in transmission the power-factor is much lower than w h
tinuous current, while the insulation has to be much bett r.
. Rankin Kennedy stated that "it is the universal idea t at
ternating machinery alone is practicable for distributing la ge
uantities of electrical energy, the supply being sent out in
ulk at 20,000 volts or thereabout, in two or three currents of
different phases, to be afterwards converted to usable pressures
and continuous current. This system, as we shall see, requires
a considerable number of step-up, step-down and rotary con-
versions. But continuous currents can be generated and
handled at high pressures with the present-day knowledge and
experience, so that it is somewhat rash to jump to the conclusion
that polyphase machinery must be preferable to continuous-
current plant for large works. It is, therefore, of interest to
refer to continuous-current high-pressure machines actually at
work in a new installation."* Mr. Kennedy described a con-
tinuous-current plant of 22,000 volts, working in Germany, and
giving highly satisfactory results. Mr. Kennedy also stated
that "considering the losses to which alternating currents are sub-
ject on small and varying loads, . . . there is great inducement to
encourage the improvement in continuous-current high-pressure
plant, . . . With continuous current, insulation is easier, and the
losses in the mains and other things are more proportionate to
the load, the power-factor is much higher, and there are no
charging losses in the wires."†

He (Mr. Kirkup), from his own personal experience, only
remembered once having had a slight fault on a commutator
through oil, and, except where the design of machine had been
at fault, he had never had to record any of the troubles
mentioned by Mr. Holiday, at least on any modern machines.
He (Mr. Kirkup) had had running continuously for nearly 5
years (Sundays excepted), a direct-current dynamo and not infre-
quently this dynamo had been subjected to an overload of 25 per

* *Electrical Installations*, by Mr. Rankin Kennedy, 1902, vol. iii., page 139.

† *Ibid.*, 1903, vol. iv., page 60.

'or long periods, and even run up to an overload of 50
ıt. at times without the least trouble. The same machine
ill the same carbon brushes on the commutator as were
by the maker when the machinery was started; there
ıt the least wear on the commutator, and the same might
l of several motors driving pumps underground. In his
.irkup's) opinion, commutation in modern machines made
iable firms presented no difficulties.
garding Mr. Holiday's remarks on the maintenance of
›hase circuits, he (Mr. Kirkup) did not think that this was
comparison with present-day continuous-current stations,
as a well-known fact, that the maintenance was very much
while the insulation had to be much more perfect in the
.

. H. M. Hobart, after making a comparison of the
ıcies of alternating- and continuous-current systems, stated
the comparison is worked out in detail, and the conclusion
l at is that the continuous-current system [when pressures
ual] will show an advantage of 30 per cent. in first cost,
7 per cent. in total yearly operating expenses for power
ıaintenance of electrical plant."*

. Holiday's experience with continuous current was
tly based on what obtained prior to 1897; but it was now
ized that electrical machinery, as at present made by
e firms, was in point of efficiency and utility entirely
or to that made in earlier days, even down to the period
by Mr. Holiday. Where electric locomotives were used
ıes they were invariably continuous-current machines. He
Kirkup) did not know of any three-phase tram or railway
e in Great Britain; and at Newcastle-upon-Tyne, the
·eastern Railway Company received three-phase current
eir electrified railway, but rotary converters were used to
:e continuous current to work the trains.†

ree-phase motors need to be greatly over-rated, when
ed to start on load, and this much increases the first cost
hat of continuous-current machines; moreover, they stop
n as their load is exceeded by getting out of step. On a
g or a coal-cutting motor, this often leaves the machinery

The Electrical Magazine, 1904, vol. i., page 452.
Trans. Inst. M.E., 1904, vol. xxviii., page 165.

ammed, necessitating its liberation by hand; whereas, with machine driven by continuous current, it would have supplied the overload needed for a minute or more without any harm resulting.

Referring to those who advocated the use of high-pressure continuous currents, he (Mr. Kirkup) had read that Lord Kelvin had recently advised a company who intended utilizing some large water-falls for generating electricity, intending to transmit it to a town a considerable distance away, to use high-pressure continuous currents, strongly commenting on their efficiency and advantages over three-phase systems: the proposed pressure was 30,000 volts. For efficiency, simplicity, reliability and general utility, he (Mr. Kirkup) considered that continuous currents still led the way; and there were many uses to which they could be put, and to which alternating currents could not be applied. In conclusion, he (Mr. Kirkup) endorsed Mr. Holiday's opinion that, in a few years, mining engineers would have had considerable practical experience with both systems, and would be able to come to a decision without having to take onesided opinions thereon.

DISCUSSION OF MR. B. S. RANDOLPH'S PAPER ON "COMPARISON OF ELECTRIC AND COMPRESSED-AIR LOCOMOTIVES IN AMERICAN MINES."*

Mr. Beverley S. Randolph, replying to Mr. S. F. Walker, desired to disclaim the title of "compressed-air" engineer. Two of the collieries under his charge happened to be placed in situations where compressed air promised the best results, and had been equipped with duplicate plants. In the largest and most economically operated colliery, the main haulage was accomplished with ropes and the gathering with animals.

He had put the subject before the members, because he considered it was unfortunate that the present rage for things electrical should be allowed to obscure a method of mine-haulage possessing so many advantages as compressed air when used under proper conditions.

The C electric plant mentioned in his paper was an old one, while the B electric plant was installed in 1902 and was up-to-date in every respect.

The rapid increase in the cost of transmission-wires with the

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 429.

ease of length, which some of the members appeared to
ition, was readily explained. The resistance to the passage
n electric current varied directly as the length, and inversely
he section or the weight of the conductor. To maintain a
tant resistance, therefore, the weight of a unit in length of
conductor must be increased as the distance transmitted was
eased. Since the number of such units necessarily increased
roportion to the length, the item of length entered twice as a
or into any expression of the total weight; and consequently,
total weight would vary as the square of this factor. To
ess it algebraically, let w represent the weight of a unit of
th of any conductor opposing the desired resistance, then
ould represent the weight of the same unit for a distance l;
the expression for the total weight of the conductor would
wl^2.

An examination of the items constituting the A compressed-
plant would show that after the first 5,600 feet of pipes, 5
es in diameter, were installed, the additions were made with
ller sizes. The ratio of the cost to the length was therefore
easing instead of increasing, as in the case of electricity.
large sized pipe was not needed for transmission; but it
ded a cheaper form of storage than would short tanks, and
introduced for this purpose. The longer the distance, the
e prominent would this feature of the compressed-air plant
me.

The difference in boiler-power, to which Mr. Ackermann
ted attention, illustrated another advantage which was fre-
tly present in compressed-air plants and did not appear to
been made sufficiently plain in his paper.

The B electric plant, as stated, was not proportioned to drive
he locomotives at once; and the conditions were such that
e was scarcely a possibility of this being needed. Three
notives were the greatest number likely to be using current
nce, and they weighed 78,000 pounds. If 20 per cent. be
ved for draw-bar pull, it would be 1,566 pounds, and at 700
per minute it would develop 10,920,000 footpounds or 333
epower. This, it would be noted, is 55 per cent. of the 600
epower at which the boilers were rated; and, while special
s might show better results, it was excellent practice to
ver 55 per cent. of the rated boiler-power at the draw-bar.

Were it desired to operate all four locomotives simultaneously at this maximum, greater boiler-power would be needed.

In the A plant, the stated boiler-power was operating the plant satisfactorily. The elasticity of the air so distributed the energy that only the average duty was called for without regard to what the locomotives might be using at any given instant. The total weight of the locomotives in this plant was 100,000 pounds. It was quite possible for all of the locomotives to be exerting their maximum draught simultaneously, and at a velocity of 700 feet per minute 424 horsepower would be developed, while the average demand for the day might not exceed 75 horsepower.

In reply to Mr. H. Davis's query as to the draw-bar pull, it might be stated that in any locomotive which depended on friction for its adhesion, this was a function of the weight and was independent of the character of the power by which the machine was actuated, where the power was sufficient to slip the wheels, as it always should be.

In reply to Mr. J. F. Lee's enquiry, regarding the cost of transmission per horsepower, there were no such figures in existence for the plants in question which had any value. The difficulty in obtaining them consisted in the practical impossibility of measuring the energy delivered by the locomotives with sufficient accuracy to make the results of any value. Attention might be called to the fact that this feature only affected the amount of fuel consumed, which was usually less than 15 per cent. of the total cost of operating a haulage-plant. A short test with a regular consumption of power would probably show to the advantage of electricity, while a day's run with heavy fluctuation of demand would undoubtedly show to the advantage of compressed air. It was true that the consumption of steam could be very closely adjusted to the needs by methods now in use, but that was not the case with the fuel consumed. Something could be done by regulating the draught, but not enough to prevent large losses where the fluctuation in demand was excessive.

In reply to Mr. H. C. Peake, the cost of operating these plants was subjoined. In this comparison there was a difficulty with the A plant, owing to the fact that 40 per cent. of the weight of the locomotives was used for gathering. At times they were fully loaded, at others they were hauling only one car, or passing from room to room without any load, to say nothing of switching. It

would therefore be misleading to compare their results with those of locomotives running continuously with full loads. In this comparison, therefore, 40 per cent. of such costs as were common to both classes were charged to the lighter machines, leaving 60 per cent. to be charged to the larger machines which hauled on the main roads and operated under conditions similar to those of the electric plants.

A. Compressed-air plant. The general daily expenses were as follows:—

	£	s.	d.
Coal, 4 tons at 4s. 2d.	0	16	8
Fireman, at 9s. 7d.	0	9	7
Mechanic at air-compressor, at 9s. 2d. ...	0	9	2
Interest and depreciation	2	1	8
Total	£3	17	1

The expense of operating the main-haulage locomotives would then be:—

	£	s.	d.
2 motormen at 9s. 4½d.	0	18	9
2 brakemen at 8s. 11½d.	0	17	11
General expenses, 60 per cent. of £3 17s. 1d.	2	6	3
Repairs and oil	0	12	6
Total	£4	15	5

The locomotives hauled 160 tons per hour or 1,600 tons per day of 10 hours over an average distance of 6,140 feet. The cost per ton moved per 1,000 feet would therefore be 0·001165d.

B. Electric plant. The operating expenses were as follows:—

	£	s.	d.
4 motormen at 9s. 4½d.	1	17	6
4 brakemen at 8s. 11½d.	1	15	10
Fireman at 9s. 7d.	0	9	7
Mechanic at generator, at 9s. 2d.	0	9	2
Oil, etc.	0	2	9½
Interest and depreciation	2	5	10
Repairs	0	4	2
Coal, 6¼ tons at 4s. 2d.	1	6	0½
Total	£8	10	11

This plant hauled 1,560 tons of coal per day over an average distance of 8,825 feet. The cost per ton moved 1,000 feet would

therefore be 0·001497d. This excessive cost was due to a lo— heavy grade against the load.

C. Electric plant. The operating expenses included:—

	£	s.	d.
2 motormen at 9s. 4½d.	0	18	9
2 brakemen at 8s. 11½d.	0	17	11
Repairs and oil	0	8	4
Fireman at 9s. 7d.	0	9	7
Mechanic at generator at 9s. 2d.	0	9	2
Coal, 4 tons at 4s. 2d.	0	16	8
Interest and depreciation	1	13	4
Total	£5	13	9

During the month of April, 1904, this plant delivered coal at the rate of 152 tons per hour, or 1,520 tons per day of 10 hours over an average haul of about 8,000 feet. The cost per ton moved 1,000 feet would therefore be 0·001125d. The conditions were much the same as at the A compressed-air plant, although the longer haul gave a slight advantage to the electric plant in this comparison, in that there was less total time lost in coupling and starting during the course of the day.

When this and the number of estimated factors which necessarily entered into the case were considered, the results of A and C plants might be regarded as identical.

DISCUSSION OF MR. S. L. THACKER'S PAPER ON "THE DYNAMICS OF THE WINDING-ENGINE."*

Mr. S. L. Thacker wrote that he presumed Mr. Lindsay Galloway referred to the method of counterbalancing by means of a bundle of chain-cable suspended in a staple-pit, either by a round rope and a subsidiary drum, or by a flat chain and reel, the diameters being so proportioned that the suspending rope was unwound and the whole of the cable rested at the bottom of the staple-pit at the middle of the wind. With this arrangement the average load-line would approximate closely to that in Case II.,† but it would not be quite uniform, owing to the weight of the suspending rope or chain.

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 445; and 1904, vol. xxvii., page 443.

† *Ibid.*, 1903, vol. xxvi., Plates XII. and XIII., page 464.

Taking the data in Case I.,* the moment of the unbalanced load due to the rope was (6,500 × 10 or) 65,000 foot-pounds. If a drum, 5 feet in diameter, were used for the balance, the weight of chain required would be (65,000 ÷ 2·5 or) 26,000 pounds, and the depth of the staple-pit would be ((23·8 ÷ 2) × 5 × 3·1416 or) 187 feet. The increase in the quantity B, in Case II.,† due to the additional weight of rope, was 339,534 foot-pounds, and of this quantity 254,850 foot-pounds would be saved in the above instance, without taking into account any small increase in the quantity C, owing to the weight of the additional drum.

He (Mr. Thacker) was not aware of any modern winding-plants being erected on this principle, and for that reason he had not included it in his paper. As Mr. Galloway was aware, the question of expense and mechanical complication presented some difficulties in adapting this method for deep winds.

DISCUSSION OF MR. VICTOR WATTEYNE'S PAPER ON "THE PURPOSE AND PRESENT STATE OF THE FIRST EXPERIMENTS ON SAFETY-LAMPS AND EXPLOSIVES CARRIED OUT AT THE FRAMERIES EXPERIMENTAL STATION, BELGIUM."‡

Mr. VICTOR WATTEYNE wrote that, in order to reply fully to the different remarks made by the members on his preliminary paper concerning the experiments at Frameries, it would be necessary to give complete details of the experiments already carried out with safety-lamps. Evidently, it would be impossible to do this within the compass of a brief reply, and he could only refer by anticipation to the report which would be shortly published.§

It would suffice to remind the members that the very complete experiments conducted at Frameries, in the course of which safety-lamps, identically supplied on the one hand with vegetable oil and on the other with benzine, were compared one with the other from the point of view of safety, failed

* *Trans. Inst. M.E.*, vol. xxvi., page 451.

† *Ibid.*, page 455. ‡ *Ibid.*, 1904, vol. xxvii., page 445.

§ "Siège d'Expériences de l'État à Frameries: Expériences sur les Lampes de Sûreté," by Messrs. V. Watteyne and S. Stassart, *Annales des Mines de Belgique*, 1904, vol. ix., page 947.

reveal any marked differences from that point of view. H
l not relied on a mere opinion, but on positive facts when I
serted that the exclusion of volatile oils was no longer justi
ole, that the regulation by which they were barred could
earlessly eliminated, and that the use of any kind of oil (pet
leum, for instance, as suggested by Mr. W. N. Atkinson)
even a mixture of oils should now be permitted.* It was har
necessary to add that he had solely in view the risks incur
within the mine. With regard to the danger which atten
the existence of stores of volatile oils at the surface, and
premises where the safety-lamps were made ready, there co
be no question that it was a very real one and suitable pr
cautions should be taken to meet it.

In regard to the possible risks attending internal relighti
in atmospheres containing fire-damp, exhaustive experimen
had been carried out, leading to conclusions which favoured th
use of relighters made of phosphorized paste. It was manife
however, that these conclusions emphatically presupposed th
the lamp had remained intact; and no experiment was nee
to prove that the relighting, in an atmosphere containing fir
damp, of a safety-lamp, the glass of which was broken or th
gauze punctured, would most assuredly start an explosion.
a matter of fact, the objection raised by members of T
Institution of Mining Engineers had been previously raised
Belgium, at the meeting of the Commission entrusted with th
Revision of Mining Regulations, and it was by no means a bas
less objection. But, in order that such a danger should ari
so exceptional a concourse of circumstances would be necessar
and so rarely would the suggested conditions occur, that
might be unhesitatingly asserted that this fresh risk would
more than counterbalanced by the advantages attending the
of the internal igniter, and on the whole there would be
positive gain from the point of view of safety. It would
remembered, and engineers, who, like himself (Mr. Watteyn
had often had the opportunity of going through the workings
a mine after an accident, would agree that few lamps were
found damaged to such an extent as to be no longer safe
lamps excepting only such lamps as had been crushed by fa

* New rules have been promulgated by the Royal Decree of August 9th, the Ministerial Decree of August 19th, 1904, *Annales des Mines de Belgique*, vol. ix., page 1357.

ck—in which event the pitmen would certainly not trouble
ck them up, far less to relight them. Moreover, it might
bserved that the shields, with which in future all lamps
prized for Belgian mines known to be fiery would most
bly be furnished, formed an extremely efficient protection
e gauze. As to the glass of the lamp, it would be admitted
it was only when bits were really broken out of it that it
d to act as a screen against external ignition. Then, too,
miner would be put on his guard against the postulated
er by some such rule as follows, which could be inserted
e regulations:—"Whenever extinction has been produced
fall, shock or any other cause, that might possibly damage
amp, the relighter shall not be brought into use, until and
s it has been ascertained that the safety-lamp is absolutely
t."* To say the truth, however, a rule of this kind would
no sanction behind it; but it would serve to remind both
gers and men of the dangers that might, in certain eventu-
s, attend relighting, and thus put them on their guard
st any abuse of the practice. Nevertheless, whatever,
utions one might take, the risk would remain, and slight
might be, would yet suffice to forbid internal relighting,
it not that, from the point of view of safety itself, the
ice did afford certain special and very real advantages.
as well known that, be the system of lock adopted
it might, the ingenuity of the miner, stimulated by
nterest which he had in not losing more time than could
ly be helped, always discovered a means of opening the

The frequent recurrence of instances of this foolhardi-
was proved by the numerous infractions of the regulations
ted by the inspectors of mines in Belgium. As to the
e of miners after a mining disaster, he (Mr. Watteyne)
not dismiss from his mind the tragic remembrance of
s of 10, 15, nay 20 corpses of men stopped in their flight
ds a breathable atmosphere by an unimportant fall of
easily got over if they had had but a flicker of light to
them. Failing that, and finding no means of retreat,
had been suffocated where they lay. Granted that the
ter would not always work properly under these conditions

* This rule had been incorporated in the ninth article of the Royal Decree of
9th, 1904, *Annales des Mines de Belgique*, 1904, vol. ix., page 1359.

and yield a helpful result, if it only did so on the occasion of one disaster out of many, even so the gain would be enormous.

Mr. Carl Beyling (Gelsenkirchen, Germany) wrote that Mr. Watteyne's paper was very interesting, inasmuch as it denoted that while progress was being made in lamp-testing, the subject of the higher atmospheric pressures prevailing in deep mines and the increased dangers of fire-damp due to its density, were receiving consideration. The results were what were obtainable in a general way and there was nothing really advantageous to be gained therefrom; and the results should be accepted, if accurate data were at hand as to the mode of carrying out the experiments and the attendant restrictions.

Referring to internal igniters, he (Mr. Beyling) might remark that there were many different forms—in Germany, at least—in which the ignition was brought about by friction on a combustible phosphorus pellet; of these he might specially mention two, namely:—(1) Those with an igniting pellet of white phosphorus on a paraffined linen strip; and (2) those with an igniting pellet, which consisted essentially of red phosphorus and chlorate of potassium on a strip of paper. The method of bringing about ignition differed, of course, as also the arrangement of the igniter, in the two kinds of igniting strips.

According to experiments made at the Gelsenkirchen testing-station, safety-lamps fitted with No. 1 igniter were rendered safe by the employment of a single wire-gauze; while safety-lamps, fitted with No. 2 igniter, were not reliable unless fitted with a double-gauze cap, and no degree of safety could be assured in lamps fitted with both forms of internal ignition when taken into explosive mixtures of fire-damp.

In conclusion, he (Mr. Beyling) thought that the lamp of the second type was decidedly superior to the first, inasmuch as the igniter of the second was more reliable, it did not become covered with smut, the candle-power was consequently greater, and the internal igniter was much easier to insert into the lamp. He did not think that Mr. Watteyne's short paper admitted of much discussion, since the results of the experiments appeared to be just what might have been anticipated.

Mr. James Ashworth (Chaddesden) wrote that, in this short paper on the work of the Belgian Mining Department, no mention was made of the lamps under test excepting two or

three, whereas the names of the explosives were given. He hoped that the experiments would distinctly prove the safety or otherwise of lamps with phosphorized paste or other means of immediate relighting, as he always had had, and still had, very grave doubts as to the safety of even a double-gauze lamp if the relighter was put into use immediately after a safety-lamp had been extinguished by an excess of fire-damp. Such a condition appeared to be similar to the tests made by Mr. J. B. Marsaut with electric-spark ignitions in a lamp full of fire-damp, and few lamps would survive an explosion when fully charged with fire-damp and air. He (Mr. Ashworth) took exception to the statement that lamps which were well supplied with benzine yielded incomparably better light than lamps fed with oil, and was prepared to submit a lamp burning mineral-colza for any tests which Mr. Watteyne might elect to make; but he was in entire accord with the statement that a good light was an essential element of safety in mines and a protection against innumerable accidents. He (Mr. Ashworth) also thought that tests on the safety of safety-lamps ought to include the addition of sulphuretted hydrogen gas to fire-damp, as he had quite recently met with an outburst of this gas in a gaseous mine; further that the hygrometric state of the atmosphere ought to be carefully noted, and the atmosphere also artificially damped and heated up to 80° or 90° Fahr.; and lastly, tests should be made upon lamps with reduced as well as with full-wick flames. He (Mr. Ashworth) believed that any illuminant, whether liquid or gaseous, could be used with entire safety in a safety-lamp if the lamp were constructed for the use of such illuminant. Experiments on explosives ought also to include a strong air-current opposed to the force of the explosive, and also saturated with moisture.

DISCUSSION OF MR. A. R. SAWYER'S PAPER ON "THE TRANSVAAL KROMDRAAI CONGLOMERATES."*

Mr. A. R. Sawyer (Johannesburg, Transvaal) wrote that he had had his attention drawn to the report on "The Rock-slide at Frank, Alberta Territory, Canada,"† which caused the displacement of 90,000,000 tons of material from the ridge and side of a

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 457.

† *Ibid.*, 1903, vol. xxvi., pages 34 and 158.

mountain 3,100 feet high, and its spread over a square mile of valley to an average thickness of 45 feet. The distance from the top of the slide, following the slope, was 2½ miles, and the motion of the rock resembled that of a viscous fluid. As pointed out in his (Mr. Sawyer's) paper, such rock-slides probably also occurred after the deposition of the Witwatersrand series. The débris consisted of boulders, blocks and rock-fragments of varying sizes, which, being subsequently cemented together, might resemble parts of the Kromdraai Conglomerates or breccia.

DISCUSSION OF MR. GEORGE A. STONIER'S PAPER ON "GRAPHITE-MINING IN CEYLON AND INDIA."*

Prof. G. A. Lebour (Armstrong College, Newcastle-upon-Tyne) wrote that he regarded Mr. Stonier's paper as a very useful one. The subject of graphite and its occurrence was one of special interest in connexion with the many possible modes of origin of that mineral. In the Ceylon deposits, where the graphite occurred in branching veins in granulites of presumably Archæan age, it seemed difficult to imagine a supply of hydrocarbons beneath from which the pure carbon might have been derived by sublimation. If the graphite were really due to a process of this kind, the hydrocarbons must have come from above. But was there any evidence of any plentiful supply of rock-oil or other hydrocarbons in rocks above the granulite? Or was there any evidence of the former existence of such overlying hydrocarbon-bearing rocks? In the absence of such evidence, if Prof. Max Diersche's theory were the correct one, in this case it must be assumed that such newer rocks had been denuded away. This was, of course, possible, but must always remain hypothetical only. On the other hand, it seemed more easy to imagine the presence of underlying masses of iron-material, and from an iron-magma graphite might well have crystallized out, as Prof. H. Moissan had shown. Against this view Mr. A. K. Coomáraswámy pointed out that the rock-fragments and minerals included in the veins would have been much altered by the high temperature required. He (Prof. Lebour) could not think that, in the absence of much more microscopic evidence

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 536.

han had yet been adduced, this objection could be regarded as atal to Prof. Moissan's theory. In graphite, which he lately eceived from Ceylon, there was a very distinct arrangement of he mineral in light and dark alternate parallel bands. He ·ould suggest that information as to whether this banding was arallel to the veins or across them, might help them to arrive t a conclusion as to the mode of origin of the graphite.

Mr. JOHN PARKINSON (Cambridge) wrote that there were wo recent publications which bore upon Mr. Stonier's paper. 'he first, by Mr. A. K. Coomáraswámy, was one of the Adminis-ation Reports of Ceylon for 1903. The author remarked that lthough graphite occurred in scattered crystals in both the ranulites and crystalline limestones, yet it was of economic nportance only when veins could be found crossing the folia-ion of the crystalline rocks. It was interesting to note that ıis graphite appeared to be inexhaustible.

The second paper concerned an occurrence of graphite in the lgonkian rocks of the Eastern Adirondacks described by Prof. . F. Kemp. The mineral occurred in a coarsely crystalline state ı pegmatite veins, and was associated with a group of minerals [uartz, felspar, pyroxene, hornblende, mica, calcite, scapolite, patite, sphene, etc.), which recalled forcibly the associates of he graphite-bearing rocks of Ceylon.

The association of wollastonite and graphite mentioned by Ir. A. K. Coomáraswámy in the paper that Mr. Stonier had uoted, was parallel by an instance described by Mr. A. Osann ·om the Ottawa valley Here roughly parallel veins of graphite ·curred in crystalline limestone. With the graphite were found ure fibrous wollastonite, green pyroxene and sphene. In other arts of the valley, the mineral association was again almost lentical with that of Ceylon, though apparently not very ›mmon, for usually graphite itself filled the veins. These facts ppeared to be worthy of close attention, not merely on the part f the miner, but on the part of those who were interested in the rigin of veins from the purely scientific point of view.

Mr. GEO. A. STONIER wrote that some of the veins showed ›anding parallel to the walls. The origin of the graphite was bscure. There was no evidence, known to him, of the previous ·xistence of overlying rocks, which contained quantities of

hydrocarbons and had been denuded away. One was compelled to look to the rocks adjoining the veins or underlying masses for the source of the mineral. The first possibility was not supported by facts, and there only remained deep-seated masses which could have contributed the carbon. Prof. H. Moissan's theory of an iron-magma was interesting, but it was difficult to understand how the iron could have been removed from, and the graphite left in, the veins.

The other two theories: (1) liquid hydrocarbons and (2) sublimed hydrocarbons, provided for most of the peculiarities of the occurrence, although, as Prof. Lebour pointed out, it was difficult to account for deep-seated supplies of hydrocarbons.

DISCUSSION OF MR. A. R. SAWYER'S PAPER ON "THE SOUTH RAND GOLD-FIELD, TRANSVAAL."*

Mr. J. M. LIDDELL (Newcastle-upon-Tyne) wrote that the dolerite of the country was, he thought, most frequently found in sub-aërial or interbedded sheets, which thinned out gradually from their point or line of origin, although many of them were intersected by pipes and dykes of different dates of formation. He had never seen any clear evidence of glacial scratchings, although masses of clay were found somewhat similar to the boulder-clay. Granite, as an intrusive rock, was very rare in his (Mr. Liddell's) experience of South Africa. He agreed with Mr. Sawyer that the granites lying north of Pretoria and east of Heidelberg were the basement-granite of the country, and that they extended to the East Coast, forming the northern boundary of the Barberton gold district and showing again in the neighbourhood of Steynsdorp and Swaziland. The gold-system of the Rand broke off so suddenly, as to suggest that much of the original basin had been destroyed. The fragments extending northward, including the Devil's Kantoor, near the Kaap Valley, did not compare in richness with the main line. It would be interesting to discover what relation the diamond-ground of Pretoria bore to the Witwatersrand formation, as it was so much nearer than the Kimberley mines, and therefore more likely to show the relative positions of the diamond- and gold-bearing systems.

* *Trans. Inst. M.E.*, 1904, vol. xxvii., page 546.

Passing westward through Malmani and Lichtenburg, gold had been reported at sundry points, and it was unfortunate that so little had been written on the Angra-Pequeña district of Great Namaqualand before it was closed to British prospectors. Possibly it was a continuation of the same great field, and a comparison of the two might have helped both and have indicated a line of probable prospecting across the Kalahari desert.

Mr. Dunbar D. Scott's paper on "Mine-surveying Instruments—Part II.," was read as follows:

MINE-SURVEYING INSTRUMENTS.

Part II.*

By DUNBAR D. SCOTT, Houghton, Michigan, U.S.A.

Introduction.

The writer has contemplated with much pleasure the growing interest in the tendency towards the attainment of the greatest possible accuracy, combined with the least possible effort, in the performance of mine-surveying operations and the adoption of the instruments and means designed to secure these economic results.

He had not previously reserved the right to appear with a second argument; but his first treatment of this interesting subject has been apparently received with so commendable a spirit of indulgence that, in the light of subsequent events, he felt justified in bringing forward a few more ideas, both old and new, which he could scarcely submit without imparting to them some of his own personality, though, as a rule, he preferred to state the various propositions simply, allowing the greatest freedom of interpretation on the part of his readers.

In the nature of things, much of the information that he has compiled was of American origin, although he endeavoured to eschew that phase of the discussion which had unfortunately involved a tincture of international semi-political controversy as was not the ultimate aim, even though the universality of subject seemed to invite it.

As he had previously remarked, the real importance of present discussion did not, in his mind, hinge so much the divination of meritorious ideas as upon the ability to them. In America, it is true that many of their appli possess an essential principle that has been imported; and

* Part I., *Trans. Inst. M.E.*, 1902, vol. xxiii., page 575,

not to be disputed that they eagerly study the best of foreign innovations and formally adopt them; separately if desirable, or in harmonious combination, for there is scant national distinction in the technical and business circles in that country.

The Three-tripod System.

A more striking example could not well be introduced than the very question of the three-tripod system of mine-surveying, to which Prof. H. Louis believed that the writer had done an injustice.

This system, as used to-day, he had attempted to show, originated in Germany in 1798, and, according to the best evidences that he had thus far found the time to consult, it appeared that General Johann von Komarzewski brought it to France, independently, in 1803. It was not until Mr. C. Combes introduced his excentric telescopic theodolite in 1836, however, that the candle-socket was used there.

In England, as Mr. Arthur Beanlands had pointed out, we read of it first in Mr. Butler Williams' *Practical Geodesy* (1842); and while American literature on the subject, so far as he knew, was silent until 1870, it seemed that Prof. W. M. Gillespie taught it at Union College (Schenectady, New York), in connection with the Combes theodolite, as early as 1850.

In reality, General Komarzewski's instrument belongs to the *eisenscheibe* class, in which there are no telescopes, and although it has been used with three sets of tripods, a plank wedged in position across a tunnel, or shaft, is the more common support. It represents one of the first and most successful attempts to devise an instrument that should, at once, possess all the requirements for taking simultaneously angles, in both horizontal and vertical planes. The circles of Jars and Duhamel were graduated in 1787-1790, but were not so perfect in design, and errors had been committed by their use. They were devised upon the recommendation of the French Council of Mines, by which body it was proposed, many years previously, to expel the compass entirely from all mine-surveying operations.

It was acknowledged, at that time, that the principal reason why the compass had not been superseded by the *astrolabium* or plane-table was because of the room required for their operation.

In 1790, Komarzewski visited the Cornish mines, where he became more than ever convinced that something should be done to perfect an instrument which should be compact in form, easy of manipulation and, as compared with the magnetic needle, reliable in its findings. Even before this he became acquainted with Herschel, who gave him a description of the great theodolite and introduced him to General Roy, its inventor, who then had it in use, in an extensive trigonometrical survey, to determine the difference in latitude and time between Paris and Greenwich.*

In 1791, Ramsden made a similar instrument to the order of the East India Company. When, however, they found that they could not afford so expensive an instrument, it was purchased by General the Duke of Richmond, to conduct topographical surveys for the Government. In order that his corps of engineers should become familiar and expert in its use they were ordered, under the personal supervision of Ramsden, to remeasure General Roy's base-line on Hounslow Heath, as well as the sides of several triangles on St. Ann's Hill. In this work Komarzewski participated, and while in conference with Ramsden conceived of the idea to reduce the great theodolite in size, suitable for mining surveys, in about the proportion that a pocket-watch bears to a steeple-clock.

In 1795-1796, Komarzewski was studying the mines at Freiberg, which were under the economical and skilful management of Prof. Lempe, to whom he described the Ramsden theodolite. Lempe showed him the *eisenscheibe* of Kumpel, which, like that of Von Oppel (1749) and Schultze (1747), was intended for the measurement of horizontal angles only. With these instruments the suspended clinometer was still used.

The dominating desire to construct a simple, cheap and compact, yet accurate, instrument for use in mines that should answer every requirement, demanded under such conditions, now occupied the minds of Komarzewski, Lempe and Studer, and the Ramsden theodolite seemed the only instrument worthy of imitation. In 1795, Studer made for Komarzewski the instru-

* "The Ramsden Dividing Engine," by Mr. J. Elfreth Watkins, *Annual Report of the Board of Regents of the Smithsonian Institution to July, 1890*, page 738. The first Ramsden engine, 30 inches in diameter, was completed in the spring of 1768; and the second, built during 1774-1775, is now in the custody of the Smithsonian Institution, *ibid.*, page 732.

ment illustrated in Fig. 1, which was probably the first of its particular kind ever introduced. The system of stretching cords was still retained in place of the expensive telescope which they believed could not possibly be used in dark mines, but the catenary curve induced by the suspension of the compass and semicircle had no longer to be taken into serious account.

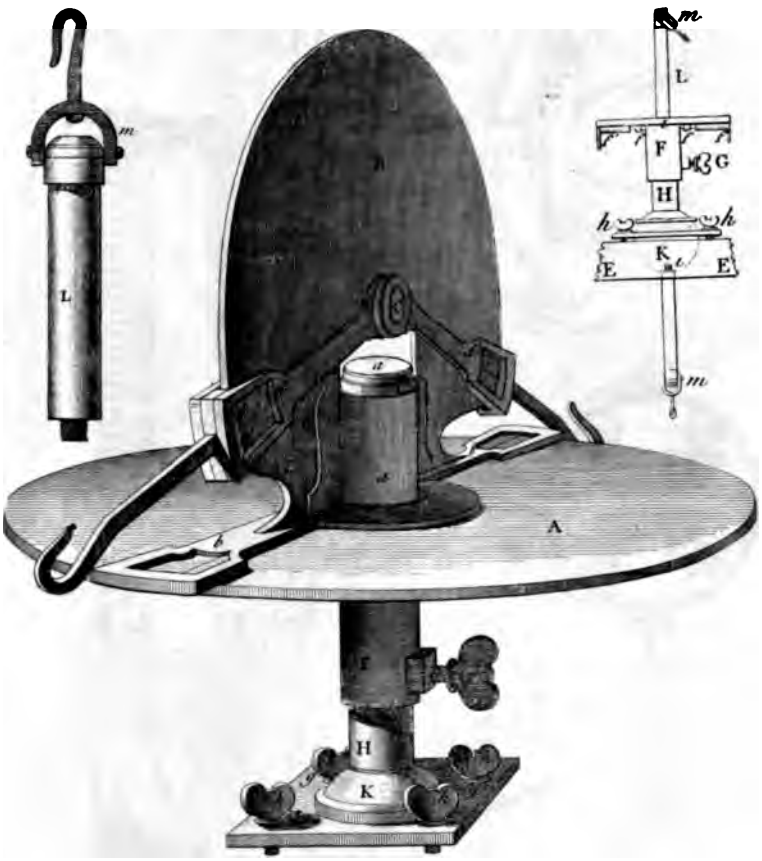


FIG. 1.—THE KOMARZEWSKI MINE-SURVEYING INSTRUMENT, 1795.

In use, it was customary to employ three sets of bases, HK, upon the spindle of which, the under-socket of the instrument, F, was clamped by the set-screw, G. At the forward and back stations, the swivel-headed spindle, L, was used as previously explained, so that the elevation of the hook should be equal to that occupied by the centre of the instrument, C.

eldmessungskunst oder Scheibenmessung (Langensalza,
. Werner describes and illustrates an improvement
Zollmann instrument (1744), which was designed to

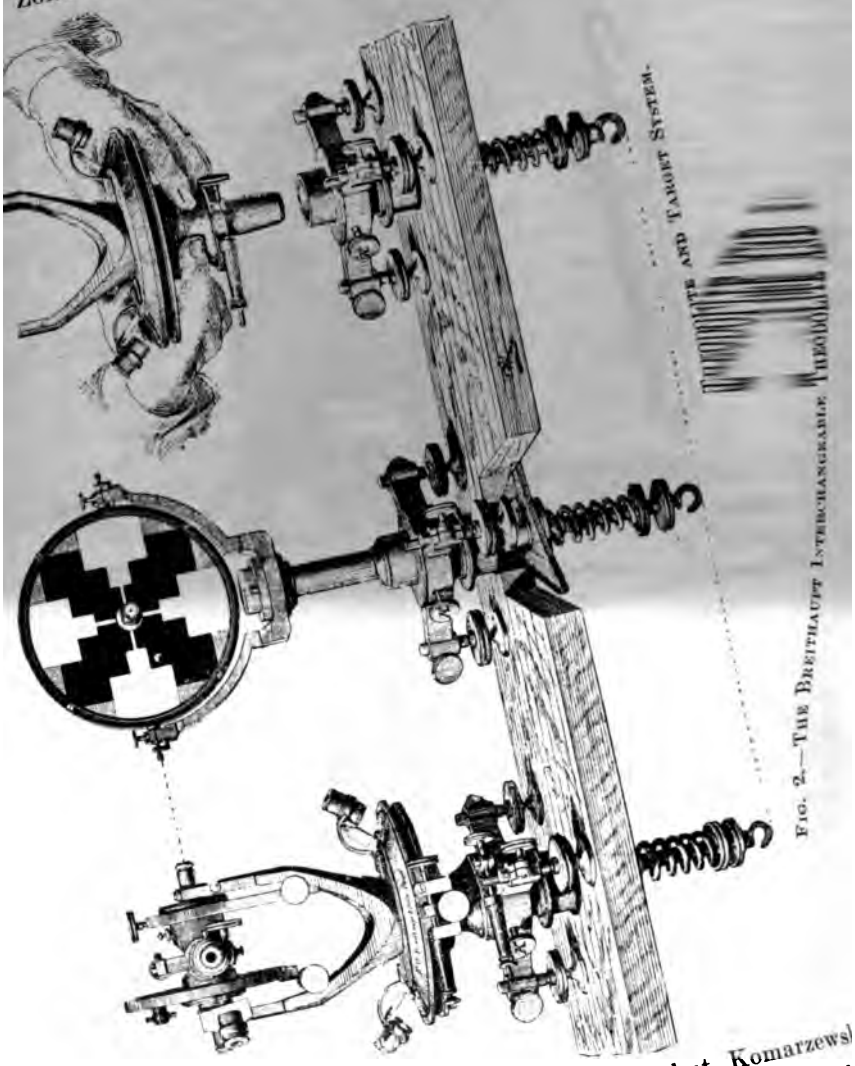
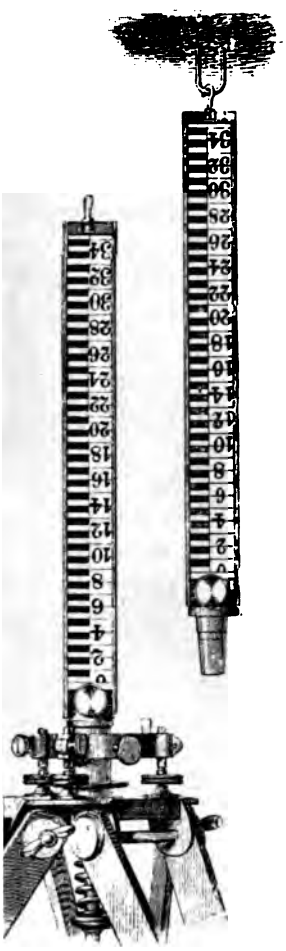


FIG. 2.—THE BREITHAUPT INTERCHANGEABLE THEODOLITE AND TARGET SYSTEM.

take both horizontal and vertical angles, but Komarzews
angleometer was doubtless the first of its class to be
underground.

ne two most popular of the German systems in use at the nt time do not seem to have been described in these *ractions.*



3.—STADIA-ROD FOR USE IN HE BREITHAUPT SYSTEM.

The Breithaupt system (Fig. 2) is of the improved pattern. Recognising the existence of many adversaries, articles were especially written* with a view not only of extolling the merits of the three-tripod system, but of showing that the objections based upon extra assistance and expense were not well founded. Among other converts was Dr. Hammer, who wrote at once commending it.† Fig. 2 shows the method of setting up with the *spreitzen*‡ and *stengelhaken* or hooked bar, extending below, with a stout spring operating against a three-cornered plate to hold the *dreifuss*, or tribrach, firmly in place. Fig. 2 is prepared with great care, to show how conveniently, by loosening the set-screw, K, the theodolite and signals may be exchanged from one base to the other. The illustration fails to show the annular recess, about the vertical axis, into which the ring-clamp fits when it is adjusted to the socket. This feature appears in Fig. 3, which illustrates the method of using transparent

* "Die Aufstellung des Breithaupt'schen Theodolits mit Signalen in der ," by Mr. Wilhelm Breithaupt, *Oesterreichische Zeitschrift für Berg- und ıvesen*, 1895, vol. xliii., page 39; "Le Théodolite de Mines de Breithaupt," *evue Technique*, 1895, vol. xvi., page 231; and "Teodolito de Breithaupt," r. Claudio Guitián, *Revista Minera, Metalúrgica y de Ingeniería*, 1895, vol. page 88.

† *Zeitschrift für Instrumentenkunde*, 1895, vol. xv., pages 343-344.

‡ Literally, spreader; really, a plank-support wedged between the side-walls rift, tunnel, etc.

ods* in this system either with the tripod, the Borchers brackets, or any other convenient or desirable means of support. A scale divided into half centimetres (0·2 inch) is recommended for use, in the measurement of the usual short courses to be met with in mines. If the galleries or tunnels are too low to permit of the use of such rods, a couple of plugs, or tape-stakes, are inserted into the socket of the *dreifuss*, but if the tape is graduated so that the ring must be hooked over the centreing-peg, great care must be exercised (in drawing the tape taut) not to upset the tripod or otherwise disturb the position of the support.

The form of signal-target shown in Fig. 2, in all the essential details of construction, except the possibility of swinging it in its horizontal axis, was introduced in 1859. Mr. Prædiger used a target or signal of simple construction in 1836, and in 1832 the Imperial Brazilian Mining Association of London were supplied with something similar to accompany the first of all telescopic theodolites known to have been used in mines.

The Freiberg system of setting up the interchangeable theodolite and signals had its origin in the support devised by Prof. Junge about 1860, when, after much laborious investigation with the erratic hanging compass, he introduced a light goniometer, without a vertical circle, to use with the suspended clinometer and cord system of underground surveying. Below the triangular base of his instrument projected a suitable steel spindle that was threaded at the lower end. This was inserted through a hole bored in the station-plank, or wooden head of tripod, and clamped in an upright position by a hand-nut and washer, C (Fig. 4).

The original goniometer, as noted, was intended only to supersede the hanging-compass; but, in applying a telescope to this ancient system of surveying with a cord, it was necessary to have also a signal, which, to suit these peculiar requirements, need not necessarily possess any particular height, but specially provided with means to level it. The cord was attached to the spindle of the theodolite just below the tribrach, B, and from there drawn tightly around the groove in the stem, *b*, of the target. The suspended clinometer was then

* "Ramsay Improved Levelling Staff for Use in Mines," by Mr. W. Trans. *Inst. M.E.*, 1890, vol. i., page 293.

from the cord for the determination of the vertical angle. For this system the *spreitzen*, A, was much preferable to the tripod, as it would sustain almost unlimited tension in the cord.

Fig. 4 has been selected from one of the very few Swedish works on mine-surveying,* and represents an outfit made by Mr. C. Osterland, of Freiberg, who had added a vertical circle to the goniometer and supplied a box-bubble, *d*, for lack of a better way of correctly setting the signals. It aimed at the

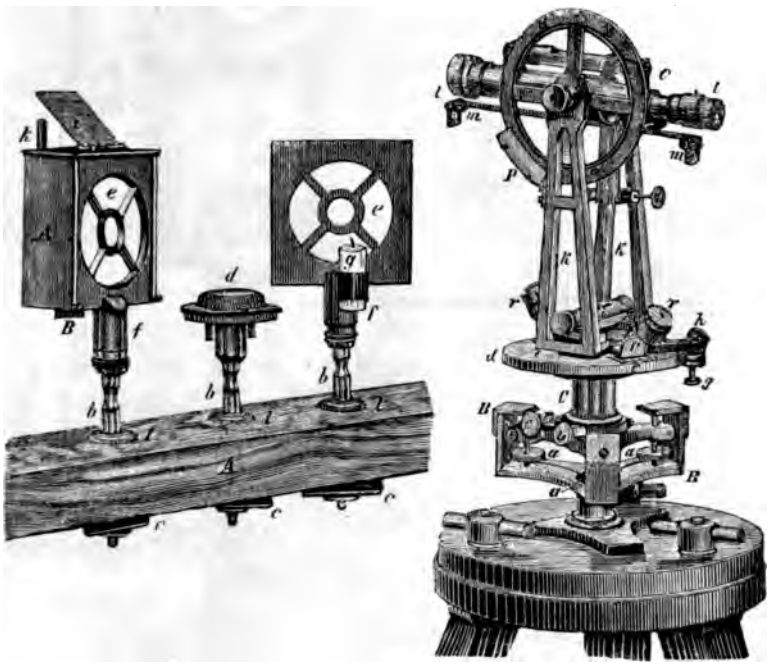


FIG. 4.—THE JUNGE-STAPPF SYSTEM, 1865.

horizontal adjustment of the *spreitzen*, A, but that guaranteed nothing with respect to the signal, which stood in a separate auger-hole that had been bored as vertically as might be determined by the eye.

This rather simple contrivance underwent some modifications at the hands of Eichof-Osterland, Goder, Otto, and Börner, but that introduced by Mr. Max Hilderbrand (successor to Mr. Aug.

* *Studier i Markschejderi*, by Mr. F. M. Stappf, Stockholm, 1866, page 44.

reiberg, in 1876 and now generally known as the
ufstellung, seems to be the most popular. Of thi

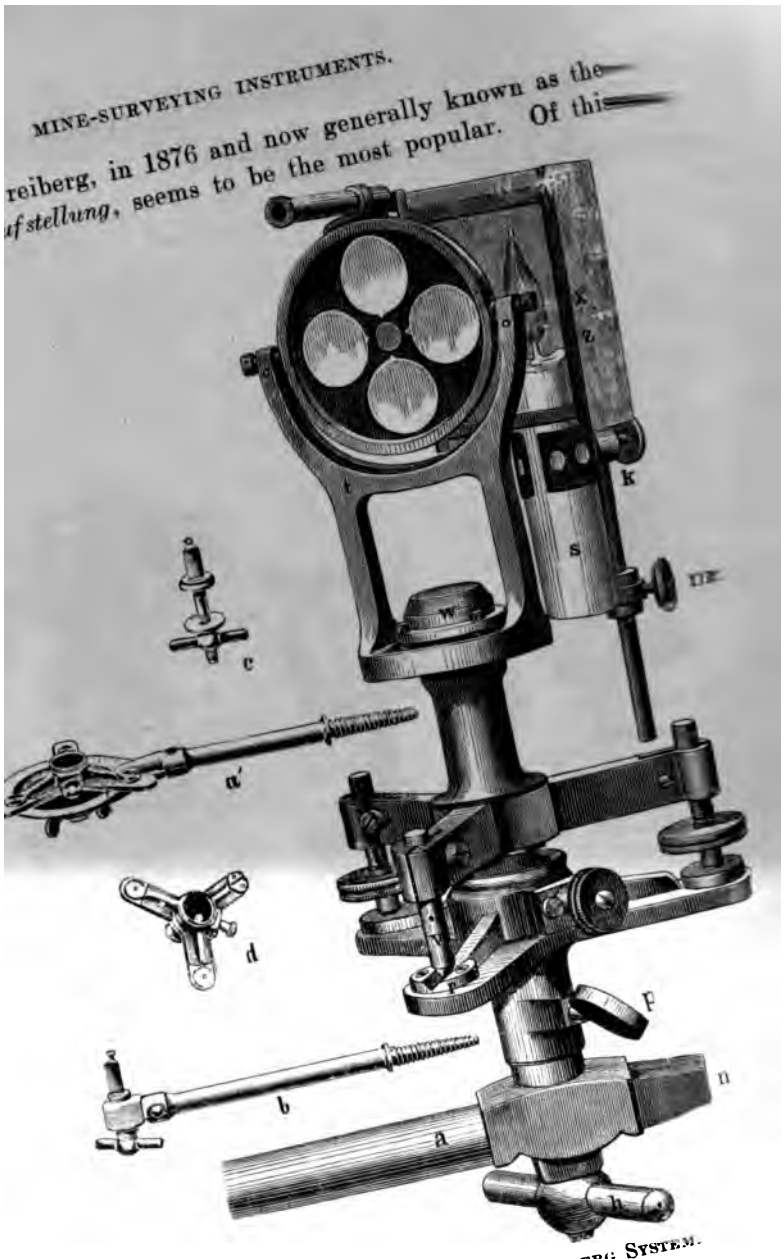


FIG. 5.—THE SIGNAL OF THE FREIBERG SYSTEM.

system, an illustration (Fig. 5), of the signal* only, is
for, excepting the blank peg, *v*, the bases are, in the main

* *Vermessungskunde*, by Dr. C. M. Bauernfeind, sixth edition,
1879, page 320; seventh edition, Stuttgart, 1890, vol. i., page 338;
neue Aufstellung," by Dr. Max Schmidt, *Berg- und Hüttenmännisch*
1880, vol. xxxix., pages 77 to 80.

ilar. The inclinable transparent disc may be set to the mal sight-line of the theodolite by peering through the little e or diopter at the top. The horizontal axis of this disc, as all cases of this kind, is equal in height with that of the odolite. The illustration shows a box-bubble, *w*, although it ow more common to use two small bubble-tubes set at right les—one within this space, and the other just above, between target-standards. In Fig. 5, the candle-socket and its ector seem to be poised in mid-air; but the lower part of candle cuts off from view the adjustable arm, which connects vertical axis of the target with the small clamp, *m*, in such manner that the candle-socket may be moved around izontally, or forward and backward, independently of the get itself. If the disc steeply inclined forrd, as in a precipitous ht, it will be necessary slide the candle, with its lector, upward through clamping-ring at *m*. e reflector is preferably plied with a sheet of a in front, and a little d to protect the flame. The intermediate applie, *d*, shown in Fig. 6, as ll as upon the bracket, is called the *untersatz*, l will be so designated these remarks. Its conuction will be better derstood after an examination of Fig. 6. The vertical axes of th the theodolite and the signal terminate in a spherical largement, *i* and *i*, which fits into the cartridge of the *untersatz*. is clamped in place by a spring-actuated piston that can be leased by winding up the nut, *n*. The lower opening in the ntersatz, triangular in shape, fits over the prism-bar, *p*. Referring again to Fig. 5, the prism-bar appears conspicuously n the miniature cuts, *b* and *c*. In *b*, it is applied to the bracket which was previously screwed into the timbering with a wrench,

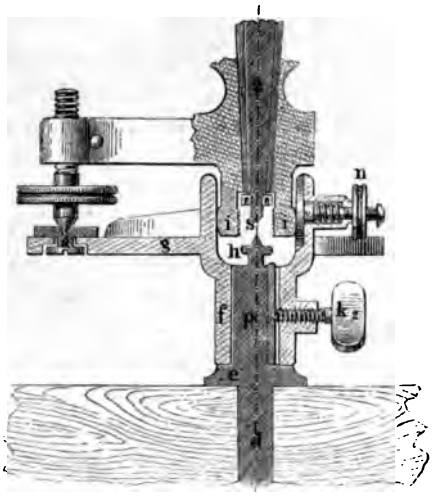


FIG. 6.—A DETAIL OF THE FREIBERG SUPPORT.

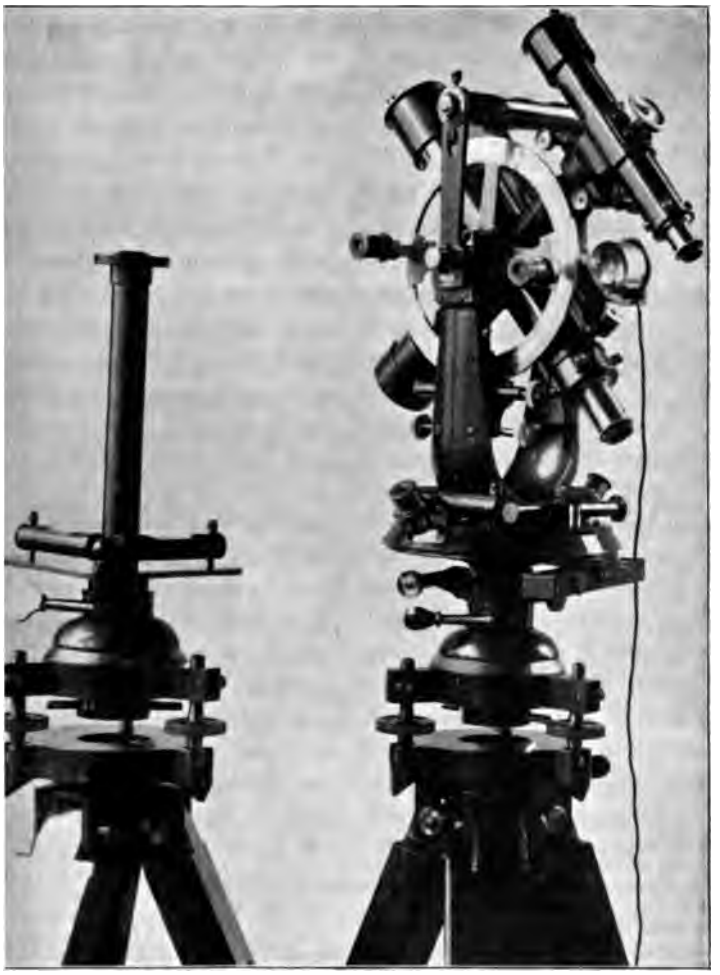
as at *n*, but it has since been the custom simply to bore a hole through the outer end and use one handle of the hand-nut, *h*, as a winding-lever. The upper end of the prism-bar terminates in a neck as at *h*, in Fig. 6. To this neck, the steel-tape may be hung; or, if one prefers, a cord may be fastened between them and measurements conducted with a rod.

Occasionally also, these prism-bars are used with the cord for conducting a hanging-compass survey. When working with the signals it is not necessary that the prism-bars should be set exactly vertical or the *untersatz* exactly horizontal, but without the signals this would be necessary.

Last year, Mr. W. F. Stanley, London, made to order for use in Cornish mines, an interchangeable three-tripod system (Fig. 7). The instrument and candle-sockets are mounted upon the Stanley ball-head, as introduced in 1896, for use with the tribrach base. It is said to be the only levelling-head in use with the tribrach principle, and an improvement over the Hoffman-Harden head in that the three levelling-screws do not have to perform the double function of locking and levelling. It is readily applicable to the Stanley triangular tripod-head, which may be detached for use in setting up the instrument upon a masonry wall or any other improvised support upon which the lower projecting points may securely rest. The instrument is provided with the author's auxiliary telescope, which within the past eight years, since its introduction, has found its way into all the important mining districts of the world, where surveys have to be conducted in highly-inclined slopes. In appearance, it seems rather formidable, but in practice it is very easy of manipulation. The writer has been told of an English engineer, who, in going to a remote district in British Columbia to examine a gold-mine for London capitalists, found such an instrument as this at the mine upon his arrival. After scrutinizing it with a critical air, he denounced it as "a complicated Yankee contrivance," and secured a Hedley dial as a desirable substitute. Much of course depends upon education, precedent and prejudice, as well as preference, but the writer trusts that this formal introduction may conciliate a true friendship among those who might otherwise remain perpetually at a distance.

One side of the horizontal axis of the instrument shown in

7, is pierced, and at the outer opening is placed a small which not only protects the interior of the telescope from ure, dust, etc., but concentrates the rays from the electric upon a small reflector in the telescope. The little



7.—The Dunbar-Scott Tachymeter, with Candle-socket Signals.

descent lamp is fitted with small clutches, that engage the ards and may be applied or removed at will. Two light ulators are furnished, of suitable size to carry in the t. One of these will be customarily charged while the is in use. A more convenient, safe and satisfactory means

of illumination could scarcely be devised. It must not be understood that the writer has ever used, or believed that the candle-socket is the most approved type of signal to be used in mines.

In America, it may be assumed that mine-surveying began about 1820, when the coal-mines of Pennsylvania were first systematically worked. It is difficult to say what system was first used, but it is very probable that, after some of the simpler magnetic methods, the transit was employed both with, and without, the three sets of tripods. The interchangeable tripod-system was taught by Prof. Gillespie in 1850; and Prof. Peck included it in his course when, in 1864, the School of Mines was established in connection with Columbia College. The first American literature upon mine-surveying, which had come to the writer's notice, emanated from the two sources just given* and was published simultaneously in 1870. The first edition of Mr. W. M. Gillespie's *Land-surveying* appeared in 1851, but his manuscripts upon *Higher Surveying* were never edited for publication until his successor, Prof. Cady Staley, did so in 1870.

The first fourteen editions of Mr. J. B. Johnson's work† do not deal at all with the three-tripod system. Mr. Russell believed that the so-called difficulties of mine-surveying were largely imaginary, and that it was useless for the engineer to encumber himself with many paraphernalia. In the fifteenth edition, Messrs. Stockton and Arthur give directions for the proper use of of the method, but confirm Prof. W. G. Raymond's‡ conviction that it is to be recommended only for coal-mines, or for gallery-floors lying nearly horizontal. Mr. Schellenberg's§

* (1) *A Treatise on Levelling, Topography and Higher Surveying*, by Mr. W. M. Gillespie, edited by Prof. Cady Staley, New York, 1870 and 1887, pages 105-114 (in the edition of 1897, pages 401-424 were written by Mr. E. P. Dickey, of Pittston, Pennsylvania, who uses three transits on occasions); and (2) *Elements of Surveying and Levelling*, by Mr. Charles Davies, New York, 1870, pages 259-270. by Prof. H. T. Peck. This was Mr. Davies' last revision of his own work, first published for students at West Point in 1830. In Prof. J. H. Van Amringe's revision of 1883, pages 338-374 were written by Mr. John G. Murphy, of Wyoming.

† *Theory and Practice of Surveying*, by Mr. J. B. Johnson, New York, first edition, 1886, pages 333-355, by Mr. C. A. Russell, of Boulder, Colorado; fifteenth edition, 1900, pages 349-399 were entirely rewritten by Prof. R. S. Stockton, of the Colorado School of Mines, and Mr. E. P. Arthur, of Cripple Creek, Colorado.

‡ *A Text-book on Plane-surveying*, by Mr. W. G. Raymond, New York, 1896. pages 305-321, assisted by Mr. J. J. Ormsby and Prof. H. I. Randall, of the University of California.

§ *A Treatise on Plane-surveying*, by Mr. Daniel Carhart, Boston, 1887, 1893, etc., pages 380-395, by Mr. F. Z. Schellenberg, of Irwin, Pennsylvania.

ays that there are obvious objections to the extra weight of the ggage, and that not all instruments are made for such ready parate handling.

Mr. R. van Norris in an article on "Anthracite Mine-surveying,"* says that in the mines under the control of the Pennsylvania Railroad Company, a surveying party usually consists of five men using the interchangeable tripod-system. The flame of the usual lamp was found to be too coarse for accurate work,† so that it was discarded for a piece of $\frac{1}{16}$ inch wire about $\frac{3}{8}$ inch long, properly adjusted before the lamp. In practice, he finds that great care must be exercised to prevent the plates from slipping while carrying the instrument from one tripod and setting it up upon another, for in a continuous azimuth-survey, any slight error induced by several such transfers would cause serious discrepancies in the final results. In his experience, however, errors greater than 3 minutes in closing a traverse of fifteen or more stations have been rare.

Prof. Hall,‡ of Lafayette College, believes that the difficulties which characterize underground surveying are numerous, and says that there is no branch of surveying which requires more careful methods and more systematic prosecution of the work. He recommends the interchangeable tripod-and-target system as being rapid and accurate, as "the vertical angle for each course is obtained directly and the distance between stations can be conveniently measured parallel to the line of sight."

From the best evidence, therefore, that we are at present able to collect, from American writers who have committed themselves on this subject, it appears that they are nearly equally divided as to its merits; and that, generally speaking, the division occurs along geographical lines in which the coal-miners are nearly unanimous as its advocates, and the metalliferous miners of Lake Superior and the Western States are arrayed as its opponents. Both sides are right, according to their particular needs.

* *School of Mines Quarterly*, New York, 1890, vol. ii., page 328.

† "The Grubb Sight for Surveying-instruments," by Sir Howard Grubb and Mr. Henry Davies, *Trans. Inst. M.E.*, 1902, vol. xxiii., figure 5, page 122.

‡ *Plane-surveying*, by Mr. Paul C. Nugent, New York and London, 1902, pages 324-353, by Prof. W. S. Hall, of Easton, Pennsylvania.

There can be no doubt that, if the engineer has expe assistance in the selection of stations and in the setting up the signal-targets, it is the most rapid method of running temporary traverse even on steeply inclined planes for, if t target is of the same height as the instrument, the verti angle observed need not be corrected. On the other ha extra assistance is required to take care of the apparatus, and pioneer-surveying the extra weight and luggage could not well considered. The use of the signals, too, almost necessit the selection of station-points in the floor of the level, if th are to be preserved, which is not a commendable practice; for the very attempt to preserve and number such points will ve ry likely be defeated by the shifting of tracks, derailing of tra n- cars, etc.

The Objective Prism.

The practice of carrying a subterraneous survey up a verti al shaft by telescopic observation began when the telescope w as first used in mine-surveying—and even before that. Giuli ni applied the principle in a very primitive manner to the sighti ng tube of his *katageolabium* in 1798.

The essential requirements have been a reasonably dry and shallow shaft, and a sufficiently long prismatic ocular, as shown in Fig. 34 of the writer's preceding paper.* As even reasonably dry shafts are rare, and the adjustment of the diagonal eye-piece requires time and patience, the more common alternative has been to utilize the reflector at the objective end of the telescope.

In 1842, Borchers attempted to make observations in all altitudes, by attaching to the objective of a concentric telescope a reflector that moved, and could be clamped, in any position within an arc of 90 degrees. A vernier-scale was properly applied as a part of the mechanism, to determine the angle o deflection in whatever position it might be placed.

In 1847, Prof. Steinheil, of Munich, introduced the simp 45 degrees objective prism, for astronomical purposes in c nection with the meridian circle. Some time between that and 1852, Prof. S. Stampfer, of Vienna, who was doubtless first to employ it, attached it to the powertul telescope

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 614.

nsitive Y-level, for shaft-surveying.* Since 1874, the writer inks that it has been used in England in connection with the lescopic Hedley dial, and in America it has been employed ith transits having no auxiliary telescope.

In theory, the objective prism professes to project a point in rticality, with a degree of precision depending upon the curacy with which the telescope may be brought to a truly rizontal position. This possibility, however, has always been estioned, for although the appliance may be accurately made, id the several parts may be in harmonious relationship, the rtainty of its reflecting surface, when casually applied to the jective, occupying a position of exactly 45 degrees to the pre-ously adjusted line of collimation, cannot be assured.

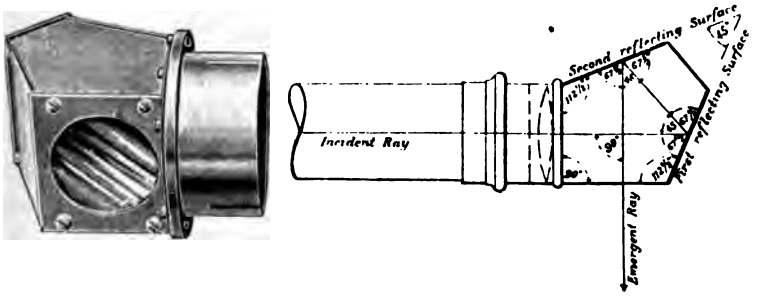


FIG. 8.—THE SAEGMULLER DOUBLE-REFLECTING OBJECTIVE PRISM.

In 1897, Mr. Saegmuller introduced his double-reflecting jective prism, which is more perfect in design, but not likely enjoy a greater popularity, as the inherent defect in all jective prisms is difficult of elimination. It is shown in erspective and theory in Fig. 8. The principle of its con-ruction is not new, but its special application to mine-survey-ig is probably without precedent. The property of two plain eflectors, by which any angle subtended at the eye, as between ıy two objects, may be measured, was utilized in the sextant, ıe Hadley quadrant, the Troughton reflecting circle, etc. The nstruction of the Saegmuller prism is founded upon that ptical law which provides that a ray of light reflected twice the same plane makes, after its second reflection, an angle ith its original direction equal to double the angle included etween the reflecting surfaces.

* *Anleitung zum Nivelliren*, first edition, 1845 ; second, 1847 ; third, 1852 ; th, 1864 ; sixth, 1869 ; etc.

use the device for its intended purpose, first sight any with the telescope steeply depressed. Tipping the scope sufficiently upward, apply the prism to the collar of objective, and revolve it until the same point is brought to apparently bisected by the cross-webs. The visual plane ll now be a vertical one, so to speak, and when the telescope-ubble is adjusted to horizontality, the deflected sight will pierce he nadir, as far removed from the centre of the instrument as the prism itself. If this process be repeated upon the four quadrants, the intersection of lines joining points so established, will mark, as near as may be, the position of a line passing vertically down through the centre of the instrument. This is the only method, conceivable to the writer, by which the objective prism could be used for optical plumbing.

If a direction only were required, as in the River Severn tunnel or in the Dorchester-bay sewer, it would be best to set the instrument on both sides of the shaft, in the alignment, and, presupposing a slight error of divergence, see whether the two directions so established were parallel.

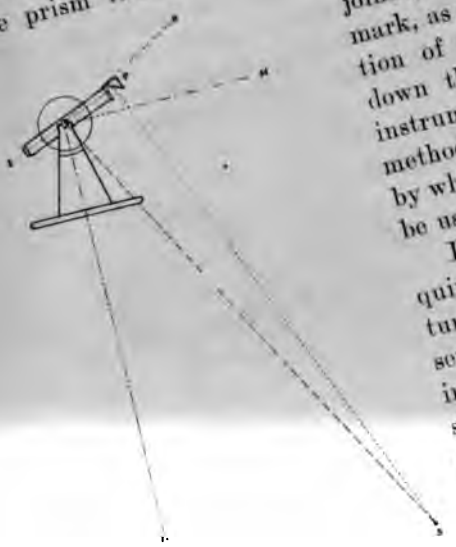


FIG. 9.—DEMONSTRATION OF THE OBJECTIVE PRISM.

If the attachment is to be used for the observation of v

precipitous angles, below the range of the telescope, the appa angle of elevation is, of course, not the one sought. Hoskold, replying to Mr. Pollitzer,* says that the simple recommended to conduct this work with his instrum termed the "complementary-angle measurer," but whoev so denominated it had christened it with a misnomer. at Fig. 9 will dispel this illusion, and show that the prism is wholly unsuited for the observation of co direction of which passes through the limb of the instru

* *Trans. Inst. M. E.*, 1902, vol. xxiv., page 503.

is supposed to be such a course; OH is a horizontal line; HOS is the angle of declivity sought; and HOP is the angle of elevation read. Now, if the angle POH is the complement of the angle HOS, the right angle must be at the point, O, but we know definitely that the 90 degrees angle of deflection is at P. As there cannot be two right angles in the same triangle, the angle POS must be less than a right angle, and its value can only be determined after calculating the variable value of the angle OSP. The value of the angle OSP changes with each observation, and depends upon the relationship between the measured distance, PS, and the amount of excentricity also carefully measured from the centre of the instrument to that precise point upon the reflector, P, at which the intersection of the spider-lines appears. Having found the angular value of POS, substract the angle POH, which has been read on the circle, and the result will be the desired one.

The accuracy of the method depends partly upon the nicety with which the correction-angle, OSP, may be determined. In focussing the objective-tube upon points at different depths, the amount of excentricity is as inconstant as the length and dip of the deflected course; and, as the one is so vastly out of proportion to the other, the exactness of the results attained must be very doubtful. The writer cannot admit that Mr. Hoskold would contest this point, even in consenting to the other, as that gentleman had heretofore been so particular about the observation of angles with the micrometrical eye-piece to the nearest second of arc.

By inverting the telescope or reversing the position of the prism, upward sights may be taken, and the orientation of a subterraneous survey established on the surface, as through a vertical shaft. For this process, it is doubtless more convenient than the diagonal eye-piece, though obviously providing less assurance of accuracy.

In his first paper, communicated to the American Institute of Mining Engineers,* the writer suggested that the mine-theodolite made by Messrs. Fric Bros., of Prague, in 1886, included the most remarkable of the modern adaptations of the

* "The Evolution of Mine-surveying Instruments," *Transactions of the American Institute of Mining Engineers*, 1898, vol. xxviii., page 731.

ojective prism; but, to indulge in a digression, he believes iat the theodolite made by Messrs. Cooke of York in 1885 (Fig. 0) is entitled to at least the same distinction. This theodolite* vas constructed upon the special order of Messrs. Tancred and

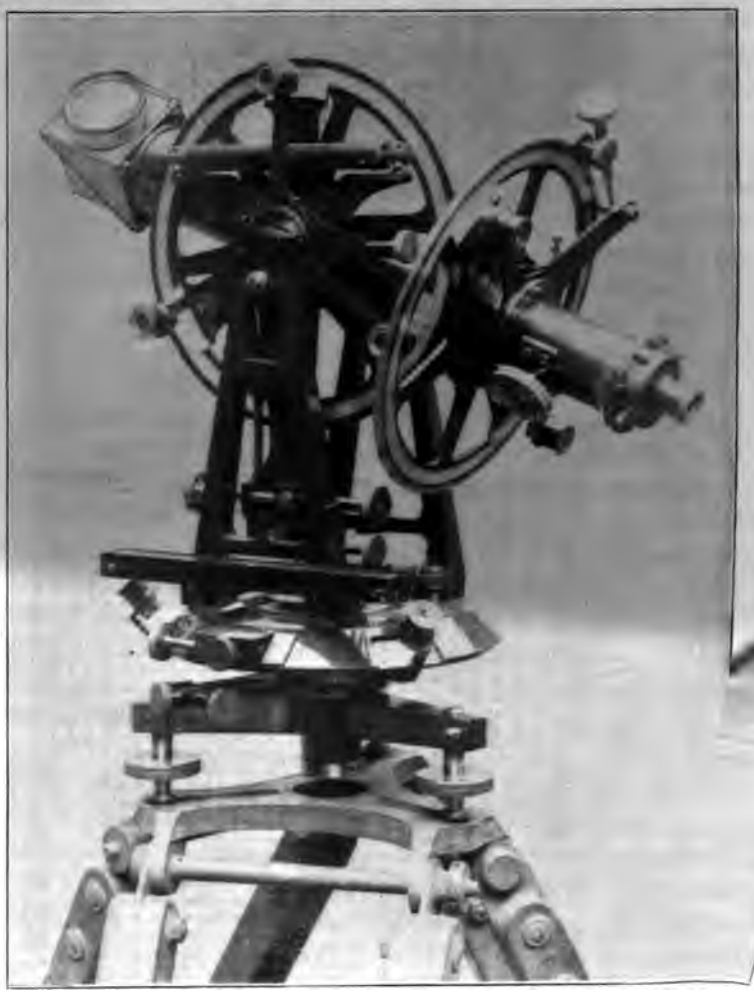


FIG. 10.—THE COOKE-ARROL-TANCRED PRISMATIC THEODOLITE, 1885.

Arrol, supervising engineers at the erection of the great steel railway-bridge across the Firth of Forth, built between December, 1882, and March, 1890.† The main members of that structure

* *Engineering*, London, 1894, vol. lviii., page 696.

† A description and account of the opening of this bridge is contained in *Engineering*, London, 1890, vol. xlix., pages 213-283.

were curved both in elevation and plan, and in order that sights could be taken along the curvilinear bracing-bars, or skew-backs, this very remarkable type of instrument was evolved. The telescope itself revolved longitudinally in an outer sleeve, cast in one piece with the horizontal axis. At the ocular end of the sleeve was rigidly fixed a supplementary vertical circle, upon which was measured the value of the angle which the deflected sight made with the vertical. The objective was of $1\frac{3}{4}$ inches aperture and of 15 inches focal length. To it was permanently attached a 45 degrees prism, which revolved in the outer sleeve, with the telescope and vernier. All three circles were 7 inches in diameter, and could be read to 10 seconds. The telescope was focussed by movement of the ocular, which ensured a fixed excentricity of the prism for its most advantageous employment in shafts. For more ordinary working, with straight sights, the whole upper mechanism was lifted out of the bearings, and a telescope of the ordinary type put in its place.

Prismatic Solar Attachments.

The operation of the American solar attachment for finding the true meridian, although Mr. B. H. Brough has taken great pains to describe one of the earliest and best forms in his work, does not seem to be sufficiently understood or appreciated in Great Britain, if we may take Mr. A. L. Steavenson's report* to represent what has been accomplished along these lines during the past 40 or 50 years. In Prof. Lupton's work,† nearly all other known methods, including equal shadows of the sun, are also reviewed; as with the Newton meridian dial, by equal altitudes of the sun, and by Mr. Warburton's method of observing the sun at high noon. The first two methods require, at least, four hours for an observation, and the third a very precise time of day, together with an accurate chronometer that engineers in the colonies and remote areas do not usually possess. With most of the approved forms of the American solar attachment, the polar meridian may be

* "The Mode of Obtaining a True North Line," *Trans. Inst. M.E.*, 1895, vol. x., page 53.

† *A Practical Treatise on Mine-surveying*, by Prof. Arnold Lupton, London, New York and Bombay, 1902, pages 356-370.

mined at any convenient moment during the day, when the is unobscured, in ten minutes of time and to within one ute of arc.

In eastern America, where most mining lands are bounded the rectangular lines of the Government survey, contrary Prof. H. Stroud's conviction,* the laying down of a meridian- ine on mining plans would be considered of no particular consequence.

In the West, for the enticement and protection of the pro- spector, a somewhat different system of mining grant prevails, yet, being once located, for official record, by a United States mineral surveyor or his deputy, and properly tied to the section- corner, any point in the concession will have a total latitude and total departure and any course, a bearing easily calculated by use of the theodolite.

If mining engineers, however, insist upon the delineation of a meridian-line, with "blazing star effects," with the *fleur de luce* and other inconsequent decoration for any traditional, imaginary or real purpose, the writer could recommend, as one of the most rapid, efficient, and universally satisfactory means of obtaining it, the American solar apparatus, of which one form came incidentally into the context of his last argument.† As Mr. J. B. Davis has thoroughly taken up the history of this device, in 1900,‡ the two forms only which have appeared since that time, will be considered here; and that more particularly because of the prismatic principle involved in their construction. Although there are several styles, all are constructed upon the principles enunciated by Mr. Wm. A. Burt, of Michigan, in 183 All aim at the mechanical solution of the celestial triang marked by the pole, the zenith, and the sun, for any given time o day or season of the year. In any of the equatorial climates, o in the southern hemisphere, where the polar star is not visible they are extremely handy, very portable, and provide, as the writer believes, in ordinary practice, the quickest and safe means yet introduced for the determination of the so

* *Trans. Inst. M.E.*, 1901, vol. xxi., page 26.

† *Trans.* [illegible] xxiii., page 608.

‡ "Surveying Instruments," by Mr. J. B. Davis, *Min. Engineers*, 1900, vol. xxx., pages

meridian. If recourse is not to be had to this means, Americans generally, although not always, prefer Mr. Arthur Beanlands' favourite method* of observing the polar star in its eastern elongation, correcting for its azimuth as well as for the projection of the same upon the surface of the earth.†

Since the design evolved by Mr. Pearson in 1875, the aim in all cases has been to so contrive the appliance, that when the proper allowances have been made, the telescope of the transit should lie in the meridian, and Mr. J. B. Davis, of Cleveland, Ohio, in 1896, was the first to apply a reflector at the object end of the main telescope in the performance of this purpose.‡ Mr. Davis preferred not to trust the scant area of the objective collar upon which to revolve the prism in following the path of the sun, and so invented an outer sleeve in which to revolve the telescope itself.

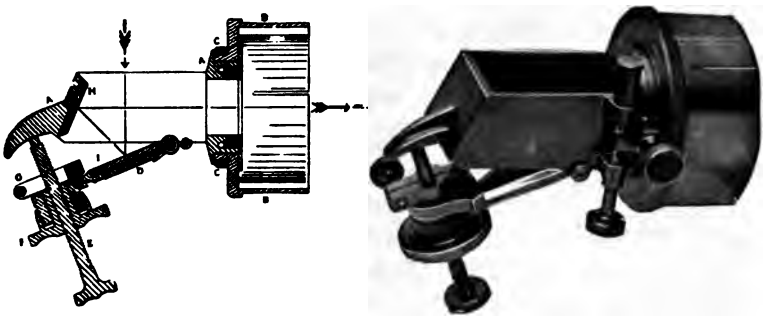


FIG. 11.—THE SHATTUCK DOUBLE-REFLECTING SOLAR ATTACHMENT.

Mr. H. D. Hoskold had also invented an outer sleeve for the purpose of transiting a long telescope in low standards.

Mr. O. F. Shattuck, of Denver, Colorado, however, reverts to the plan of rotation about the collar, *cc* (Fig. 11), in his device, which, like all objective solar attachments, is designed to eliminate the special adjustments of the polar axis as well as the latitude and declination-arcs of the Burt type. "The sun," he

* *Trans. Inst. M.E.*, 1895, vol. x., page 57.

† See also a paper on "Surveying Mining Claims," read before the Montana Society of Engineers, May 8th, 1897, by Mr. Charles Tappan, *Journal of the Association of Engineering Societies*, 1897, vol. xix., page 33, an abstract of which appeared in *The Engineering and Mining Journal* [New York], 1897, vol. lxiv., page 244; and Prof. J. B. Johnson and others, in the *Engineering News* [New York], 1896, vol. xxxv., pages 186 and 322; 1896, vol. xxxvi., page 27; and 1897, vol. xxxvii., page 315.

‡ Mr. Walter Scott, of Hot Springs, Dakota, in 1890, had previously utilized the simple objective prism in auxiliary apparatus, and also Mr. B. H. Smith, of Denver, Colorado, in 1880.

says, "in its apparent diurnal motion about the polar axis, follows a path parallel to the celestial equator, at a certain angular distance from the poles. When this angle is set off by means of the solar attachment, and the sight-line of the telescope is set at an angle with the horizon, equal to the latitude of the place, it is evident that it is impossible to view the sun on the cross-wires, and follow it by turning the attachment on its axis, except the instrument be in the plane of the meridian with the sight-line parallel to the earth's polar axis." To use this attachment for the determination of the solar meridian, one must be conversant with the interpretation of the solar ephemeris.*

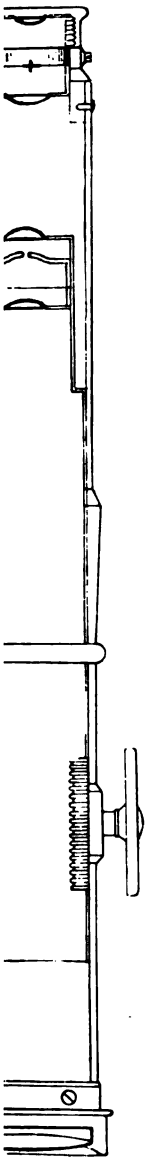
The *modus operandi* is briefly as follows:—Sight some object, a mile or more distant, with the vernier set at the angular amount of the corrected south polar distance. With the vertical axis clamped, turn the instrument back to the zero of the limb, then apply the attachment, as a sun-shade is applied, to the collar of the objective. Sight the same object through the prism, bringing the cross-webs exactly upon it by manœuvring the screw, E, which, in turn, must be clamped by the thumb-screw, G. This places the mirrors, H and I, in such a relative position that the reflected line of sight makes an angle with the line of collimation equal to the sun's polar distance. Depress the telescope, now, until the vertical circle marks the latitude of the place, then centre the cross-webs upon the sun by turning, at the same time, the transit upon its vertical axis and the attachment upon its polar axis, *cc*. Theoretically, the axis of the telescope now lies in the meridian. The hourly change in the sun's declination is corrected by means of the graduated differential nut, F. The divisions upon its periphery represent one minute of arc, and are turned to the right or left according as the declination is increasing towards the north or south.

FIG. 12. THE LALLIE SINGLE-REFLECTING SOLAR ATTACHMENT.

Fig. 12 shows a similar attachment introduced more recently

* The Shattuck attachment is manufactured by Messrs. William Ainsworth & Sons, of 2151, Lawrence Street, Denver, Colorado, who publish the ephemeris yearly for gratuitous distribution.

r. Lallie.* It is applied to the telescope in the same manner as Mr. Shattuck's, but it possesses the advantage of not entirely obscuring any other straight sight with the telescope, while so applied. Otherwise, in theory, it is nearly identical. The essential difference consists in the means of reflection. In the Lallie solar but one round mirror is used, while in the Shattuck solar the incident ray is twice deflected in its course, which, it is argued, transfers mechanical errors at the objective to the reflector-planes, where they become practically ineffective. Mr. Shattuck estimates that an error of 30 minutes in setting would not produce over 16 seconds of deviation in the deduction of the polar meridian with his attachment.



. 13.—THE RÖM-YOUNG -EXTENSIBLE ELESCOPE.

The writer has attempted to show by substantial and unbiassed logic that for whatever purpose any form of the objective prism may be used in mines, even acknowledging its inherent claims to commendation, there still exists an inconsistent condition of excentricity, induced by the focussing movement of the objective tube, which may be exaggerated and complicated if there exist any false or lost motion in the performance of this operation.

The objective prism, therefore, is best adapted for use with those telescopes which focus by sliding movement of the ocular, or with the Nyström-Young non-extensible telescope, a section of which is given in Fig. 13. This telescope was brought out by Mr. Young in 1874, and was first

* Invented and manufactured by Mr. J. S. J. Lallie, 1622, Arapahoe Street, Denver, Colorado, who also publishes an ephemeris containing full directions for its use.

applied to the McNair transit;* since which time it has been much used for mining transits, because it is hermetically sealed against moisture and, because in whatever position, it is always in perfect balance. Fig. 13 shows the arrangement of the lenses and the position of the inner sliding tube by which the focussing is accomplished. The eye-piece is of the Huyghens type, and may not therefore be used for stadia-measurement, as with the Ramsden ocular, for as we read in Mr. Parkinson's *Optics*,† "In Huyghens' eye-piece, the wires would be placed at the principal focus of the eye-glass, and would be distorted by excentrical refraction through that lens alone; while the image seen would be distorted by excentrical refraction through the field and eye-glass and consequently in a different degree from the wires. In this case the position of any point in the field would be estimated incorrectly by referring it to the wires." As noted, the internally focussed telescope is recommended for use with the objective prism, on account of the immovability of the object-glass, which feature further commends itself in considering the permanency of adjustment in the line of collimation.

Mr. S. P. Baird has observed‡ that "a large percentage of object-glasses are so excentric that it is impossible to adjust instruments so that the intersection of the cross-wires will cover points in a line which is straight both horizontally and vertically. Instrument-makers throw all error into the horizontal wire of transits and into the vertical wire of levels. The average transit therefore is not calculated to do precise levelling." Mr. William Harkness, replying,§ believed that the appreciable error was due to the inaccuracy of movement in the objective-tube, and the consequent change in the position of the optical axis. This is a consideration that Mr. George L. Griffith should take into account, although he would not contend with that writer the general utility of the instrument he describes.‖ It is precisely the type which has enjoyed such popularity in the United States

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 606.

† London, 1870, page 217.

‡ *Engineering News* [New York], 1901, vol. lxv., page 377.

§ *Ibid.*, page 449.

‖ "Notes of Surveys and Levellings in Canada," by Mr. George L. Griffith, *Trans. Inst. M.E.*, 1903, vol xxvi., page 552.

of America since 1858, when Messrs. Hulbert and Young devised and perfected the shifting centres. It cannot therefore be designated as a substitute for, or in any way connected with or dependent upon, Mr. H. D. Hoskold's instrument of 1863, which seems to be obsolete.

The Magnetic Needle.

Whenever the writer touches, even remotely, upon this hackneyed topic, he is conscious of a prejudice against it that is not malicious, but as unalterable and conclusive as the endless evidence that has, at various times, been brought against it. Prof. H. Louis' remarks concerning the magnetic "Orientation-instrument" were well selected, very appropriate, and tended to confirm his hitherto unexpressed opinion that magnetic surveys should be entrusted only to the most eminent exponents of that science which deals with the constancy of the wind and the regularity of the lightning. Compass-dials are used, as a rule, by the least informed of our mining men, whereas their appropriate association should be only with expert students of physical science. The compass, as applied to mine-surveying, is a relic of our ancient ancestry, and still there are those who cling to it in the knowledge that it is capable of losing its magnetism; that its geometric and magnetic axes may not coincide; that it is susceptible to the influence of local attraction; to diurnal variation, which changes with the latitude, temperature and season; to secular variation, which has been as great as 24 degrees; to an annual deviation; to lunar inequalities and solar phenomena; to irregular and intangible magnetic storms; to the horizontal intensity of the earth's magnetism; to electric-trolley or lighting systems, which have been known to reverse the poles; that the point of support may become blunted; that it may be set excentrically, or become bent so that the opposite ends indicate different readings; that to attach a vernier to such a device is a civilized barbarism; and that the line of collimation in the telescope is rarely coincident, or parallel, with the meridian-line of the compass.

To test this last-mentioned defect with the ordinary type of the American transit, a previously determined solar, or stellar, meridian had to be laid down. By placing the transit at one end, and sighting the other, a careful reading on both ends of

the needle was taken. This was compared with a second set of readings taken with the instrument reversed and the telescope inverted. If the collimation-adjustment was perfect, an average of the four readings would give the approximate total error. The writer doubts whether this adjustment could be tested upon the Lean, Whitelaw, Hedley and other English dials. It would be reassuring to know that, in setting out a magnetic meridian, the sight-line of the telescope revolved in a vertical plane which also passed through the north-and-south line of the compass-graduations.

FIG. 14.—THE BREITHAUPT TEST FOR CONCENTRICITY OF COMPASS-GRADUATIONS.

Mr. Breithaupt has hit upon a novel method of testing this subtle defect,* and Fig. 14 shows a small mine-theodolite [to which this method has been applied. To perform this test, depress an ocular-focussing telescope and draw the eye-piece well out toward the compass-graduations, until they appear distinct as viewed through a small peep-hole in the objective-cap. The further the eye-piece is extended, the greater will be its magnifying power, but in no position will the cross-webs be visible. However, that small portion of the graduations which shows through the diaphragm will appear sharply defined, and the test may be

* "Un Nouveau Procédé de la Vérification de la Ligne 180°-360° du Limbe de la Boussole par Rapport à la Ligne de Visée," *La Revue Technique*, 1900, vol. xxi., page 368; and "Notizen über Boussolen Instrumente," by Mr. Wilhelm Breithaupt, *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1900, vol. xlviii., page 451.

ıde with great accuracy. The small sketch in the upper part of g. 14 conveys an idea of how the division-lines appear through › celestial eye-piece. The marks for 360 and 180 degrees ›uld both be observed in this way, so as to determine any ›ergence or parallelism; a part of which may be rectified by › adjusting thumb-screws in the outer compass-ring.

FIG. 15.—THE FESSENDEN-YOUNG TRANSIT OF 1832.

But has not the proposition arrived at a *reductio ad absurdum*? compass-surveyors do not, and cannot, read nearer than legree and usually not closer than ¼ degree, why should it be vital concern if their dial-plate is 15 minutes behind the mark l 50 years behind the times?

When the first American portable transit was introduced by . Young in 1831, the late Col. John M. Fessenden (a West

Point graduate and pupil of Prof. Davies) instructed him to make what has since been designated as the pioneer-instrument. Through the courtesy of Mr. F. B. Rowell, of Boston, the writer has secured a rare photograph of the instrument, reproduced in Fig. 15. Col. Fessenden was no disciple of the compass-school. When a reading had been taken upon the circle, 5 inches in diameter, of this instrument, it was known to be exact to within a minute of arc, and the results could be recorded without any qualms as to their dependence upon some hidden particles of iron contained in the brass of which the instrument was made. When the Eastern railway to Portsmouth, New Hampshire, was completed in 1840, Colonel Fessenden presented this instrument to Mr. Francis Case, of Salem, who was of opinion that it was first used on the original surveys of the Boston, Lowell, and Worcester railway in 1830-1835. Its maker's grandson, Mr. A. C. Young, does not believe this possible, but concedes that it is one of the very first made. The graduations read in but one direction, by opposite single verniers placed at 45 degrees to the line of sight. There was no adjustment yet given to the horizontal axis, but the standards could be slightly moved in the elongated holes through which the screws passed that held them to the limb. The telescope had a power of 7 diameters, and was $9\frac{3}{4}$ inches long. A few such minor details as these have induced Mr. Young to call it the second, rather than the first, American transit.

FIG. 16. – THE SAEGMULLER STRIDING COMPASS.

The important details of construction in the best grades of modern mine-theodolites ought not to be modified to favour plans

for the circular compass, as usually placed between the standards and above the plates. Some difficulty has been experienced in so contriving the standards that they might embrace a large compass and stand the strain of years imposed by the other more important operations of the instrument.

The writer has never been able to reconcile the association of a circular compass with a graduated limb, and the combination of a telescope with the most delicately mounted needle seems a gross incongruity. Its fine definition and accurate perception are nullified by the needle's numerous inconsistencies, which were reviewed some ten years ago by Prof. H. Stroud, who, instead of boldly denouncing the magnetic needle for use in mines, attempted to explain its erratic behaviour by many hypothetical arguments.* If the engineer must fritter away his time in tabulating excuses for his instruments, he is neither earning money for his principals nor reputation for himself.

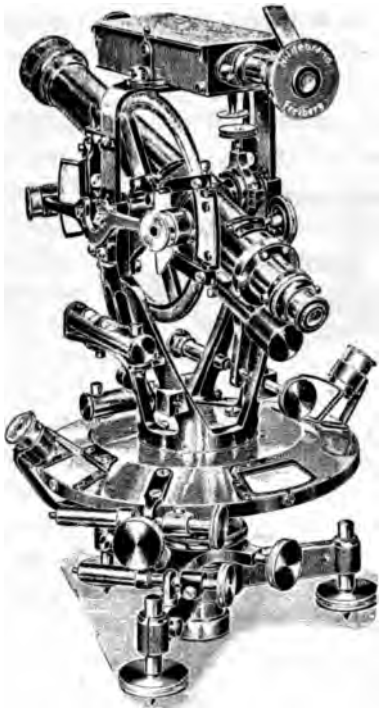


FIG. 17.—THE NEUMAYER-SCHMIDT DECLINATORIUM.

The writer does not dispute that there might occur times when the knowledge of a magnetic direction would have some significance, and for such a determination he believes the constructive features of the types shown in Figs. 16 and 17 to be the most approved. The Saegmuller instrument (Fig. 16) is a 44 inches mountain-theodolite with striding-compass, which could, and ought to, be supplied with prismatic sights to test the concentricity of the setting. The compass is entirely free to be

* "Magnetic Declination and its Variations," *Trans. Inst. M.E.*, 1894, vol. vii., page 268.

observed, and is not cramped within any certain limited space. The provision made for clamping the legs, or mountings, to the outer extensions of the horizontal axis is such as is convenient to use with the best form of striding-level, which is so very essential in straight-line work. The weight of this instrument is 5¼ pounds, and the tripod weighs 5 pounds more.

The Neumayer-Schmidt *declinatorium* (Fig. 17) as mounted upon the Hildebrand theodolite* inculcates one of the most absolute known methods of determining the magnetic meridian with ordinary sized instruments. This device is the simplified modification of the Tesdorpf instrument, previously described,† which has come down in a process of evolution through Cassini and Gambey, Weissbach, Borchers, Gauss, Bamberg, Neumayer and others in a manner too complicated for narration here. This system consists of a pair of parallel steel magnetic plates, 11 centimetres long, connected by an aluminium or magnesium bar. The supporting jewel is a precious stone with a convex cavity at both top and bottom, so that the whole internal mechanism, or duplex needle (see Fig. 18), may be lifted out of the little box and inverted for a second observation in order to eliminate instrumental errors. In front of the jewel-support is a small round mirror, also set in aluminium and as nearly as possible coincident with the longitudinal axis of the magnets. In order to hold this in equipoise, a small counterbalance, riding a threaded armlet, extends outward and behind the jewel. Through the front end of the box is inserted a small telescope of about 10 diameters power with its objective well up towards the mirror. In the top of the tube is a prism, throwing light upon the mirror that reflects the image of a pair of threads, which are viewed through the Gauss ocular. In order to adjust the small telescope to parallelism with the main telescope, the magnetic arrangement is lifted out, and a straight sight taken

FIG. 18.—INTERNAL VIEW OF THE DECLINATORIUM.

* Dr. Schmidt, *Zeitschrift für Instrumentenkunde*, Berlin, September, 1888.

† *Trans. Inst. M.E.*, 1902, vol. xxiii., page 599.

through the opening in the opposite end of the box. It is believed that, with this appliance, the magnetic meridian may be determined to within 1 minute of arc. There would be a strong incentive amongst the old school of surveyors to use such a contrivance for carrying a surface-meridian underground by magnetic observation upon a single plumb-line.

Gravitational or Mechanical Plumbing.

Mr. A. Hübner, of Halle (Germany), has shown* that Hero of Alexandria used two plumb-lines to orient a subterraneous survey in the last century before Christ, so that there is nothing especially new in the idea whether by one shaft or two; whether the instrument is ranged into alignment with the wires, or the distance between them is used as a short base for a system of triangulation. Except where the relatively simple and less accurate magnetic method has been resorted to, this means has always been employed; and wherever we find a record of the results attained by its intelligent application we are led to conclude that the necessity for the more modern alternative of visual plumbing is an hypothesis rather than a conclusive demonstration.

The most notable case of its eminently successful application was by Mr. E. S. Philbrick, of Boston, engineer in charge of the Hoosac tunnel-works, who suspended 15 pounds plummets on copper-wires in the central shaft to the level of the tunnel, 1,028 feet below the surface.† He placed finely divided brass-scales behind the wires, and after a series of observations noticed that the oscillations extended from $\frac{1}{10}$ to $\frac{5}{10}$ inch. As an additional precaution against draughts, he enclosed both wires in a board-flue (6 inches square), throughout their entire length, whereby the vibrations were reduced to $\frac{1}{100}$ and $\frac{4}{100}$ inch, although the mean position was not changed; showing that, in this case at

* *Zeitschrift für Vermessungswesen*, 1887, vol. xvi., pages 553 and 674; and vol. xvii., pages 282 and 325; *Mittheilungen aus dem Markscheiderwesen*, edited by Mr. H. Wernecke, Freiberg, 1887, part ii., page 17; *Methoden der Unterirdischen Orientirung und ihre Entwickelung seit 2,000 Jahren*, by Dr. M. Schmidt, Berlin, 1892, page 4, etc.; and Mr. W. A. Truesdell, of St. Paul, Minnesota, has published in the *Journal of the Association of Engineering Societies*, 1897, vol. xix., pages 1 to 19, a very interesting paper on "The First Engineer," showing the original instruments of Hero, one of which was restored by Venturi, an Italian commentator upon those works of Hero which were saved from the final destruction of the famous Alexandrian Library in 641 A.D.

† *Tunneling, Explosive Compounds and Rock Drills*, by Mr. Henry S. Drinker, New York. 1878, page 909.

all events, the disturbing influence due to draughts was constant, and that if the precise determination of the points of rest was made, the length of the cord subtending the arc of vibration was immaterial. He determined the time required for one full beat by the wellknown formula: $t = \pi \sqrt{l \div g}$; in which l is the length of the plumb-line, and g the acceleration due to gravity. This last factor is a difficult quantity at which to arrive exactly. Taking the value established at Washington, and correcting for latitude and elevation, it appears that, in the vicinity of the Hoosac tunnel, g is equal to 32·1912 feet, and the length of a seconds pendulum is 39·13983 inches. Substituting these values we have:—$\sqrt{39{\cdot}13983}$: $\sqrt{\text{length of plumb-line in inches}}$ :: 1 second : 18 seconds. The transit was carefully ranged into alignment with the wires, brought to rest, and the headings projected each way over a total distance of nearly 5 miles, with a lateral error on one side of $\frac{9}{16}$ inch and on the other of only $\frac{5}{16}$ inch. The variations in levels at the same points were respectively 0·09 and 0·12 feet.

A few other more recent notices of published accounts touching on gravitational plumbing may be briefly reviewed. Mr. Ellis Clark of the Glendon Iron Company, of Pennsylvania, records the successful application of the one-shaft-and-two-wire method in shafts not exceeding 4 or 5 feet square.* In depth, they varied from 75 to 200 feet, but were constantly moving out of the perpendicular on account of the caving ground about them. Mr. Clark preferred to place the transit as far back in the heading as might be possible, as the influence of any small error in setting would be proportionately lessened in comparison with the increased length of the first course. In fifteen such surveys, the wires were placed, for reasons stated, at not over 18 inches, and as close as 6 inches apart. In the Wattrig shaft, annealed iron-wire and 10 pounds plummets, suspended in thick muddy water, were used, and although only spaced 12 inches apart, the raise laid out holed perfectly into the bottom of the next shaft. These surveys were also noted in Mr. Bennett Hooper Brough's *Treatise on Mine-surveying*, a work which reflects great credit upon its author. The technical and historical

* "Shaft Surveying in the Brown Hematite Mines of Northampton County, Pennsylvania," by Mr. Ellis Clark, jun., *Transactions of the American Institute of Mining Engineers*, 1878, vol. vii., page 139.

research evinced by this remarkable compilation is unprecedented in this class of literature, and the writer believes that the ten editions through which the work has passed bear greater testimony to its worth than anything that he might at this time suggest.

Messrs. F. W. Watkins and E. Wegmann made some remarkably accurate connexions in the sixth and fifth divisions of the Croton aqueduct-tunnel.* In Mr. Watkins' section, there were six shafts, varying in depth from 57 to 205 feet, and from 3,116 to 6,926 feet apart. They were generally 8 by 17½ feet in section, sunk with the longest axis in the alignment of the tunnel. It was therefore possible to suspend wires and 25 pounds plummets more than 17 feet apart. The headings were first permitted to advance about 150 feet each way, and then the alignment was established very carefully, by several determinations upon vernier-scales riveted to iron spikes that had been previously set in the roof. The maximum error in closing of 1⅜ inches occurred on June 26th, 1882, between two shafts 3,940 feet apart. Between two other shafts, 4,280 feet apart, the minimum error of ¼ inch occurred. In nine connexions in Mr. Wegmann's division, the minimum error of ¼ inch occurred between two shafts 2,157 feet apart, and the maximum error of 1¾ inches between two shafts 2,204 feet apart. This excessive difference was attributed to the fact that the tunnel here contained a reversed curve, making an offset of 437 feet, which was introduced to avoid conflict with the old aqueduct.

Mr. Edwin A. Sperry conducted during 1891-1892 a difficult survey through tortuous openings under the bed of the Missouri river, in the Coal-measures, near Leavenworth, Kansas. The two shafts were between 700 and 800 feet deep, and nearly 1 mile apart. In plumbing the shafts, he used fine piano-wire, and inserted four wings of thin brass-plate into sawed slits in the sides of the plummets, in a manner similar to that used by Mr. N. Herrig with his quicksilver-plummets in the mines near Saarbrücken.† In one shaft, Mr. Sperry obtained excellent

* "Tunnel Surveying on Division No. 6, New Croton Aqueduct," by Mr. F. W. Watkins, *Transactions of the American Society of Civil Engineers*, 1890, vol. xxiii., page 17; and *The Water-supply of the City of New York, 1658-1895*, by Mr. Edward Wegmann, New York, 1896.

† *Mittheilungen aus dem Markscheiderwesen*, by Mr. H. Wernecke, Freiberg, 1890, part v.

lts, but unfavourable conditions in the other induced a con-
erable error, which he fortunately detected with the side
xiliary telescope. The total traverse of 31 stations and a
ngth of 10,923 feet, constructed upon two base-lines not exceed-
ng 9 feet in length, closed with a lateral error of 2 minutes 30
econds, or a lineal equivalent of 2·96 feet.*

Mr. John L. Culley, in a paper read before the Civil Engineers' Club of Cleveland, Ohio,† stated that during his experience in the coal-mines about 1881, he had seen light plumb-bobs lowered in shafts about 200 feet deep, an average taken of their vibrations, and the alignment taken off within a space of about 15 minutes, without further preliminaries or ceremony.

Mr. L. F. J. Wrinkle‡ gave an exposition of the T-square method, as used by him in an extensive experience and with ease, rapidity, and success in the mines of the Comstock lode in Nevada. He used it in shafts from 1,000 to 3,000 feet deep "making therefrom good connexions with no other assistance than that of the miners and under adverse conditions as to heat, water and draughts, the occupation of the shafts being only 4 to 5 hours." He used No. 18 or 16 annealed iron-wire and suspended 25 pounds bobs in buckets of water entirely protected from splash, except a small hole at the centre. Instead of measuring the oscillations on scales, he threw the shadow of the wire upon a piece of candle-box, nailed up behind, and marked with a pencil the middle distance between any two immediately following extreme positions of the shadow. To be certain, it was his habit to make three independent determinations at intervals of 5 minutes. Having fixed the middle distance of each wire, a straight-edge, ½ inch by 6 inches by 12 feet, or thereabouts, was applied as shown in Fig. 19, then a T-square, with a head, 8 inches long, and a blade, ½ inch thick and 4 inches wide, was also adjusted in turn to each wire. Two secondary points, or W_1 and W_2, were established, at

* "Survey of an Underground Connection at Leavenworth, Kansas," by Mr. Edwin A. Sperry, *Transactions of the American Institute of Mining Engineers*, 1894, vol. xxiv., page 25; and *Engineering News* [New York], 1894, vol. xxxi., page 182.

† "Mining Engineering," by Mr. John L. Culley, *Journal of the Association of Engineering Societies*, 1892, vol. xi., page 188.

‡ "A Method of Carrying a Survey Line down Shafts," by Mr. L. F. J Wrinkle, *The Engineering and Mining Journal* [New York], 1893, vol. lv., page 8

l distances from the wires, on the floor of the underground-
on, providing an easily accessible subsidiary base of the
› length and parallel to the interval between the wires.
Ir. A. Neustaedter,* suggested a similar method, which he
used in very small shafts, providing for the greatest possible
th of base-line by suspending the wires in "the extreme
:ent corners, lengthways of the shaft and reproducing the
:tion by offset-points on ¼ inch sticks attached to the plumb-
i and (the opposite ends) supported on floating corks; this
vs the wires freedom of motion, and at the same time steadies

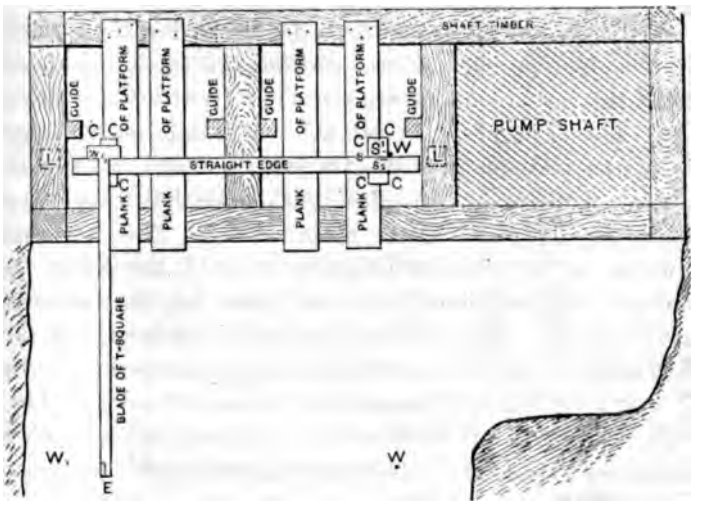


FIG. 19.—THE WRINKLE T-SQUARE METHOD OF ORIENTATION.

ɔ." One end of the delicate but rigid stick is attached
ɔe wire; and the other floats upon a large cork in a pail of
›r, set at the same level in the plat. Toilet-pins are inserted
ugh the sticks, and down into the corks at equal distances
ı the wires. The corks, having cotton-threads attached,
ı each side to the rim of the pail, are adjusted to positions
ɔh shall mark a distance equal to that between the wires.
instrument is now set up over one cork-point, and the
rior angle of the quadrilateral thus formed is observed. This
hod has given Mr. Neustaedter very satisfactory results,
ɔh are due (he believes) to the extra length of base-line

* "Method of Plumbing Shafts," by Mr. A. Neudstaedter, *Transactions of merican Institute of Mining Engineers*, 1893, vol. xxi., page 792.

possible. He expresses a preference for this method over vertical sighting.

Mr. Louis Kuhn* testified that, in some very cramped shafts, where it was not possible to hang No. 22 copper-wire over 30 inches apart, he had repeatedly conducted surveys in depths exceeding 1,000 feet, closing with a final error of less than 3 minutes.

Mr. K. E. Weiss† records the results of his experiments confirming the adaptability of the triangulation-method, as used by Prof. Weissbach prior to 1850. The instrument need not necessarily be ranged into line with the wires, but placed in any convenient position in the station, the three sides and the angle at the instrument measured very carefully, and the angles at each wire accurately calculated. He advises making the angle at the instrument acute, though he depreciates the idea of getting it too small by placing the theodolite near to, but not quite in, the plane of the plumb-lines. This is a rational conclusion, as the ultimate error, induced by the differences in trigonometrical functions, is not so great for the computation of small angles. He used a shifting tripod-head, allowing a displacement of 2¼ inches, and an extra telescope of very short focal length falling within the first metre. Previously but one triangle was used, but later practice interpolated a third point in the prolongation of the plummet-plane, which provided for a larger number of calculated angular values, to be combined for a mean resultant.

Prof. Paul Uhlich‡ gives the result of his investigations and of careful mathematical study of the various methods proposed for plumbing vertical shafts. He recommends, as superior to all others, the method of swinging plumb-lines and the careful measurement of the oscillations upon co-ordinate scales as used by Prof. Max Schmidt prior to 1882, and, as we have noticed, by Mr. Philbrick in 1871. His experiments occupied 6 hours in abundant dripping water, and in twenty-five separate deter-

* "A Method of Transferring Surface Alignment Underground," by Mr. L. Kuhn, *The Engineering and Mining Journal* [New York], 1893, vol. lv., page 179.

† "Orientirung von Gruben-theodolitzügen durch Anschluss an zwei in einen Richtschacht gehängte Lothe," by Mr. K. E. Weiss, *Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen*, 1896, Abhandlungen, page 101.

‡ "Kritische Betrachtungen über Lothungen in einem seigeren Shachte," by Prof. Paul Uhlich, *Ibid.*, page 112.

minations the results did not vary by 0·01 millimetre. The conclusion at which he arrives rejects the measurement of linear distances with the tape, in favour of angular values with a finely-divided theodolite. Having determined the nadir-points underground, he removes the wires, and carefully measures the included angles with the instrument. Where triangulation is necessary, especially at the surface, he attaches such importance to the measurement of the angles subtended at the wires, that he has the instrument-base so modified in construction that one wire may be let down through it into the shaft.

Mr. R. G. Brown* stated that he had used plumb-lines to the greatest advantage even in shafts, which dip very near the vertical, or in those which start out vertically and then change to an underlay. Fig. 20 illustrates Mr. Brown's idea, although it will appear obviously suited only to very rare cases. The inclined wire is attached to nails driven into the side of the shaft, and carefully placed so as just to touch the two plumb-lines on the same side. The fourth wire is drawn at a tangent to the longer plumb-line and the inclined wire. This method could be used to establish a meridian where the engineer possessed only the simplest kind of an instrument, not designed for steep sighting.

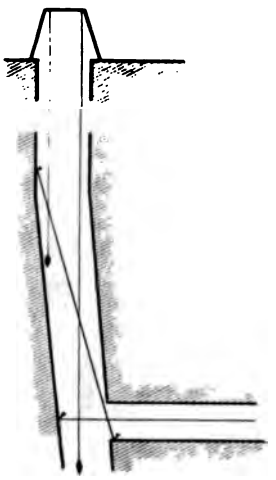


FIG. 20.—THE BROWN METHOD.

Mr. H. H. Holbert, finding himself in just such a predicament at the Rico mine in British Columbia, resorted to the novel method shown in Fig. 21. In a steeply inclined shaft he stretched a single wire between the surface, and a level below, where it was necessary to conduct a survey. Although not absolutely necessary, a set of plumb-lines at the surface and at the underground station were then applied, and the instrument was ranged into alignment at each position. To determine the co-ordinate components, however, he was compelled to devise some other expedient. This account was

* *School of Mines Quarterly* [New York], 1894, vol. xvi., page 146.

given by Mr. Joseph Barrell,* who reviewed the methods practised in the Rocky Mountain districts of America, discussing their relative merits in a most comprehensive manner.

The T-square method is widely used in that section, on account of the unusually small shafts, and the means that it provides for the greatest possible length of base, especially where the main-drift starts off in the direction of the shortest dimension of the shaft. It is not always necessary that the offsets shall be truly at right angles to the direction of the straight edge, as shown in Fig. 22, where the conditions may be so cramped that the T-squares shall be placed one above the other and turned equally upon the thumb-screws. In any event, it is of the utmost importance that the points C and D be marked with pins exactly equidistant from the wires. In an interval of, say, 8 feet between the wires, an error of 0·026 inch in the length of the line AC would change the direction of the line DC by 1 minute of arc. The T-squares, on the contrary, might differ by 4 or 5 degrees in direction before an equal error would be apparent. With this method, adopted by Mr. Joseph Barrell, it appears that work has been "correct to the minute in practically all cases."

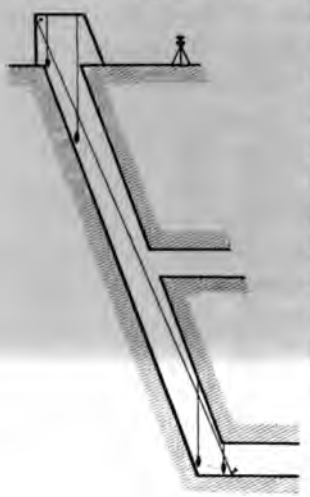


FIG. 21.—THE HOLBERT METHOD.

Mr. T. L. Carter† deprecated the use of "the four-point method," in which the attempt is made to place the instrument underground in a position directly beneath the one occupied on the surface. This is done by dropping two wires in each side of the triangle, thus establishing two directions that intersect at the instrument. He preferred the method advocated by Mr. Weiss, but modified the execution somewhat in making only the angle at the instrument an acute one by getting as far back in the first heading as possible. By such recourse, he believed that any

* "Rocky Mountain Mine Surveying," and "Corrections for Errors," by Mr. Joseph Barrell, *Mines and Minerals*, 1899, vol. xix., pages 241 and 433.

† "A Method for Carrying the Surface Meridian Underground," by Mr. T. Lane Carter, *The Engineering and Mining Journal* [New York], 1899, vol. lxviii., page 334.

slight vibration in the wires has the least effect upon the work. He also gave an account* of a successful application of this practice in the shafts, 1,500 feet deep, of the Witwatersrand district of the Transvaal.

Mr. E. Z. Burns† cordially endorsed Mr. Carter's advocacy of the triangulation-method, although he acknowledged that "the larger the number of measurements [taken] to attain a certain result, the greater the chance for error." He cited a notable occasion in which he used it, to make a connection with the bottom of a bent shaft at the Lake Angeline mine, in the Marquette iron-district of Lake Superior. In sinking from the bottom and raising from beneath on the inclined portion of the shaft, the point of connexion could not afterwards be detected. The survey which Mr. Burns was called upon to make was one of the most difficult ever presented to the mining engineer, and the results obtained bespeak commendation for both the method and the operator.

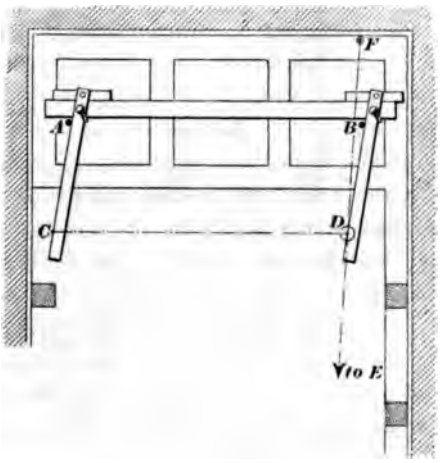


FIG. 22.—THE BARRELL MODIFICATION OF THE T-SQUARE METHOD.

Beyond question, the most extensive and difficult mine-survey founded upon the suspension of plumb-lines was that conducted under adverse conditions to remarkably successful results by Mr. J. B. Watson in No. 5 shaft of the Tamarack copper-mine in the Lake Superior district, which is said to be one of the deepest vertical shafts in existence. This shaft has reached a depth of 4,960 feet below the surface, 4,356 feet below the level of Lake Superior and 3,755 feet below the level of the sea.‡ The

* "Shaft Surveying," by Mr. T. Lane Carter, *The Engineering and Mining Journal* [New York], 1902, vol. lxxiv., page 478.

† "Carrying Surface Meridians Undergrouud," by Mr. E. Z. Burns, *ibid.*, 1899, vol. lxviii., page 573.

‡ "No. 5 Shaft at the Tamarack Mine," by Mr. W. E. Parnall, Jun., *Proceedings of the Lake Superior Mining Institute*, 1901, vol. vii., page 59, contains an interesting account of the sinking of this shaft; and Prof. O. P. Hood describes

ed Jacket shaft of the Calumet and Hecla mines is now 4,8
eet deep to the lowest level, beyond which there is a 120 fe
ump; and No. 4 incline shaft of the same mine, which ve
nearly intersects it at the bottom, has now attained the ext
ordinary depth of 8,100 feet as measured on its dip of 38 degre

In 1901, it became necessary to make a connexion betwe
No. 2 and No. 5 shafts of the Tamarack mine, at the twenty-ni
level. At No. 5 shaft, this level is 4,163 feet below the surf
and 3,220 feet in a straight line from No. 2 shaft. The worki
of No. 2 shaft, however, had approached to within 860 f
through which intermediate space the connexion was to be m
A small duplex hoisting-engine, with loose drum and brake,
placed conveniently near the mouth of the shaft, and conne
with the compressed-air column. After reeling upon the d
sufficient No. 24 piano-wire, it was let down in the end-com
ments over pulleys specially provided. For lowering the
into the mine, there was attached a cylinder, with conical
built up of wooden laths. It was 10 feet long, 2½ feet in diameter,
and weighed 20 pounds. In its centre was fixed an ordinary
lantern, so that the progress of the descent, covering 30 minutes,
could be watched, and conflict with the cross-buntons avoided.
Plummets, weighing 8 pounds, were now substituted until the
wires could be removed from the sheaves and properly fixed in the
transit-line at the surface. Finally, cast-iron bobs, weighing
50 pounds, were attached, and an elongation of 15 feet in the
lengths of the wires was noticed. After taking this up and sus-
pending the heavy bobs in suitable vessels of engine-oil, the
buoyancy of displacement induced a contraction of 25 inches i
the lengths of the wires. At the surface, the wires were fir
placed 16·32 feet apart. After assuring himself of the perfe
freedom of the wires, by 3 hours' exploration through the sh
Mr. Watson found that the wires, at the twenty-ninth le
settled comparatively quickly, and obstinately remained
repeated swayings, 16·43 feet apart. The western wire was
moved at the surface nearer to the pipe-columns, 4 and 16

the winding-engines, "Deep Hoisting in the Lake Superior District," in *M*
Minerals, 1904, vol. xxiv., page 614. The No. 3 shaft of this mine
distinction of being the deepest vertical shaft in existence. It is now
to the sixteenth or bottom level, and when the seventeenth level shall
reached, that point will measure precisely 5,200 feet below the surface
future of this great mine depends upon the further sinking of this most
group of deep shafts, it is not improbable that, in time, some of the
attained a vertical depth of 6,000 to 7,000 feet.

in diameter, until the distance between the wires was 17·58 feet (Fig. 23), and then at the twenty-ninth level, the divergence was reduced to 0·07 feet (Fig. 24). One wire, as an experiment, was then drawn aside 1 foot and fastened with a thread. The thread was then burned with a candle-flame and the great pendulum 4,250 feet long, began to swing.* Co-ordinate-scales divided into parts, equal to $\frac{1}{16}$ inch and numbered decimally, were set up; and when the vibrations had been reduced to as near quiescence as could be expected, systematic observations were

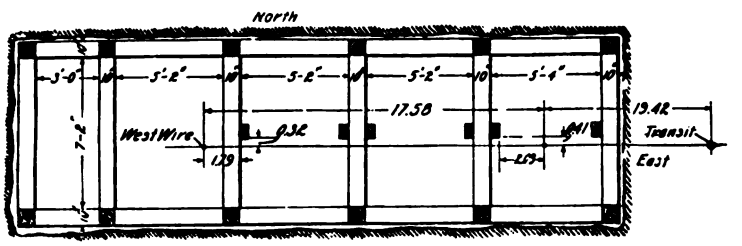


FIG. 23. - SKETCH SHOWING THE POSITION OF THE WIRES AT THE SURFACE OF THE TAMARACK MINE.

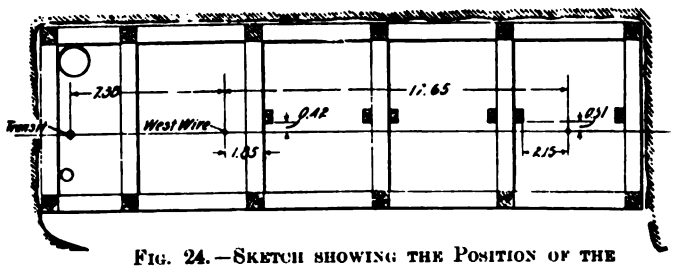


FIG. 24.—SKETCH SHOWING THE POSITION OF THE WIRES AT THE TWENTY-NINTH LEVEL AT THE TAMARACK MINE.

made occupying several hours, by which it appeared that, for the western wire, the maximum swing was equal to 0·956 inch and the minimum, 0·450 inch; for the eastern wire, the relative distances were equal to 0·656 and 0·169 inch. The mean positions were very constant, and the amount of divergence remained unchanged at 0·84 inch. Discussion upon this physical phenomenon at once became animated, and was carried

* Mr. C. Francis Jenkins believed that the 510 feet wire-pendulum suspended in the Washington Monument, June 12th, 1887, was the longest in the world. "The Telltale Plummet in the Washington Monument," by Mr. C. Francis Jenkins, *Scientific American*, 1899, vol. lxxx., page 122. This shaft, rising 555 feet above the surrounding country, is indeed a very remarkable one, but not of the kind here dealt with, and the Tamarack survey had not then been suggested.

on publicly in contributions to *The Daily Mining Gazette*, Houghton, beginning on October 8th, 1901, and ending with the articles of Mr. H. M. Lane* and Prof. F. W. McNair.†

Prof. McNair, Director of the Michigan College of Mines, being present during these and subsequent plumbings, drew attention to the Newtonian theorem dealing with the attraction upon a mass, within a closed spherical shell, suggesting that the same forces must be operative in a tube of great length. Mr. R. M. Morrison, of the Quincy mine, drew attention again to the Newtonian law which assumes that "every particle of matter in the universe attracts every other, with a force directly proportional to the mass and inversely as the square of the distance between them." Upon this theorem, he constructed the proposition that:—The length of the plumb-line: half divergence, plus half the expected convergence : : weight of bob : horizontal pull, or, say, 0·03 grain in this case.

The divergency of plumb-lines toward mountainous masses had been noticed and dealt with by precise mathematical calculation in the geodetic surveys of the Himalayan Mountains, as well as in the survey of the international boundary across the Rocky Mountains between Canada and the United States.‡ There can be no doubt of the gravitational attraction exerted by one mass upon another, no matter what the relative position, but the situation presented in the Himalayan Mountains, for instance, where these enormous mountain-masses lie on one side of a plumb-bob, with no counteracting influence on the other, is quite different from that in a shaft where, to all practical purposes, the operating forces are equal in all directions except in the vertical. Mr. Morrison, and many others, clung tenaciously to this theory: that the side of the shaft nearest the plumb-bob would have a tendency to draw the bob towards it. The writer

* "Plumbing Deep Shafts of the Tamarack Mine," by Mr. H. M. Lane, *Mines and Minerals*, 1902, vol. xxii., page 247.

† "The Divergence of Long Plumb Lines at the Tamarack Mine," by Prof. F. W. McNair, *The Engineering and Mining Journal* [New York], 1902, vol. lxxiii., page 578; and *Science*, June 20th, 1902.

‡ "Notes upon Ancient and Modern Surveying, and Surveying Instruments, Books, Tables, etc.," by Mr. H. D. Hoskold, *Trans. Inst. M.E.*, 1900, vol. xix., pages 195 and 201; "Survey of the Northern Boundary of the U.S. from the Lake-of-the-Woods to the Summit of the Rocky Mountains," by Messrs. A. Campbell and Capt. W. J. Twinning, *U.S. Geodetic Reports*, 1878; also special treatment of deflections, by Mr F. V. Green, *Ibid.*, Appendix B, pages 331-406: and *The Attraction of the Himalaya Mountains upon the Plumb-line in India*, by Major S. G. Burrard, of Dehra Dun, 1901, referring to all previous notices, supplies the latest and best treatment of this subject in India.

also participated in this belief, which seemed the only logical explanation, until he considered that even in shafts of this great depth and size, the distance between the plumb-bobs is so insignificant when compared with the distance between either one and the centre of gravity of that portion of the earth's crust which could have an uncompensated influence upon it, that this horizontal component of gravitational attraction must be considered a negligible quantity. Prof. McNair had early taken this argument into serious consideration, but he was compelled to set it aside when the results of a computation showed that the displacement, due to this force, was as small as 0·001 foot. Mr. C. Brackenbury, of Hancock, also discredited this theory, suggesting that an induced current of static electricity in the long wires may have influenced the bobs to repel each other. Prof. William Hallock, of Columbia University,* also championed the theory of the repulsion between like consequent poles distributed along the wires, but later experiments could not substantiate it.

The presence of the long pipe-columns, only 7 feet distant, shown in Fig. 24, next suggested itself as exerting some magnetic attraction upon the western plumb-bob, and there was something in the more erratic behaviour of this plumb-bob, in its irregular vibrations across the scales, which seemed to confirm such a theory; but later experiments, conducted by Prof. McNair and Mr. J. F. Hayford of the United States Coast and Geodetic Survey, showed that if these pipe-lines possessed any polarity there was no manifest horizontal component.† Had they been horizontally at the bottom of the shaft, something of this nature might have been expected.

Prof. O. Brathuhn,‡ of the Clausthal Mining Academy, reported that, in a shaft 390 feet deep, he found cast-iron plummets deflected 7·5 millimetres at the bottom; and the position of the two points thus established marked a direction deviating 6 seconds from the true-line passing through the

* *Electric World and Engineer*, February 8th, 1902.

† Recently the Tamarack Mining Company assigned No. 4 shaft to the disposal of Messrs. McNair and Hayford, who conducted some very exact and elaborate experiments in the determination of the value of g, which will be recorded in one of the forthcoming reports published by the U.S. Coast and Geodetic Survey.

‡ "Die Anwendung der Ocularskala bei den Lothorientirungen," and "Beiträge zur Markscheidekunst," by Mr. O. Brathuhn, *Berg- und Huettenmænnische Zeitung*, 1898, vol. lvii., pages 23, 155 and 163.

surface-points. In a cross-cut at the bottom of the shaft had been piled a heap of tram-rails, which had become polarized, as is well known, by long use, and to these was assigned the deflective agency. Large brass-plummets were substituted, and the lines hung perfectly plumb. This is contrary to Mr. Watson's experience. In plumbing No. 2 shaft with lines about 4,130 feet long, leaden plummets, weighing 60 pounds, and No. 20 B. and S. bronze wire were used to provide against any possible magnetic influence, but the divergence there amounted to 0·1 foot.

By elimination, therefore, Prof. McNair was led to conclude that the deflection noticeable must invariably be due to air-currents, and in this opinion Mr. Hayford concurred. In No. 5 shaft, until this survey was made for that especial purpose, there was no connexion with any other part of the mine, so that artificial circulation was produced by boarding up the westernmost compartment, which contained the piping and ladder-way. The result was a gentle downward current in the four other compartments, and to this alone was attributed the cause of so great a divergence. If this be so, it must be assumed that the air-current, passing downward, parallel to the wires, had no effect upon the eastern bob, but that the western bob was deflected in the path of the current as it passed into the westernmost compartment. This theory, in general, explains the facts observed in the suspension of non-magnetic materials or appliances in No. 2 shaft, and since it has been so far found to be the *only* one which harmonizes every existing condition with the produced effects, it possesses, to say the least, a very great degree of probability.

The practical importance of this survey resided in the accuracy with which the headings closed. This consideration seemed to have been lost in the discussion upon the probable cause of divergence in the plumb-lines, and had never before been published. The underground traverse consisted of 13 stations and a total horizontal distance of 2,706 feet. This was tied to a part of the surface-triangulation, embracing 7 more stations and 3,374 feet; or, in all, 20 stations and 6,080 feet. Combining with this the interval at the connexion, there is an aggregate of 6,940 feet of surveyed lines which closed at the third to within 4 inches in elevation, 4½ inches in length, and 27 inches laterally. As a matter of fact, Mr. Watson dropped

lines to determine the azimuth for the connexion at No. 5 shaft, on three different occasions, deducing therefrom three slightly varying results. It was found by comparison later, and in substitution of the different findings, that had the first been used the lateral error would have been practically nothing.

This method of orienting subterraneous surveys has been in use now for about 2,000 years, and it seems as though the innumerable and remarkably accurate results attained by its skilful application have stamped upon it the seal of approval for all time. This conclusion is at variance with the plausible argument advanced by Mr. G. R. Thompson,* who had shown that, from a theoretical standpoint, considerations attending its use conspired to condemn it.

There had existed a sentiment against it, founded upon the relative shortness of base-line, which had recently led Mr. G. C. McFarlan to devise in its stead, a most original, not to say desperate, means of establishing two points underground in the vertical plane of the line traversing the mouth of the shaft. Mr. McFarlan stated that† he first suspended heavy bobs on fine steel-wire in a shaft 190 feet deep. To verify the alignment, he checked the established direction with the Saegmuller solar attachment, which showed a variation of 3 minutes. He then used the main telescope of his transit as shown in Fig. 25. "Two of the tripod legs were shortened and set on the shaft sill 4 inches from the edge; the third leg [being extended] was

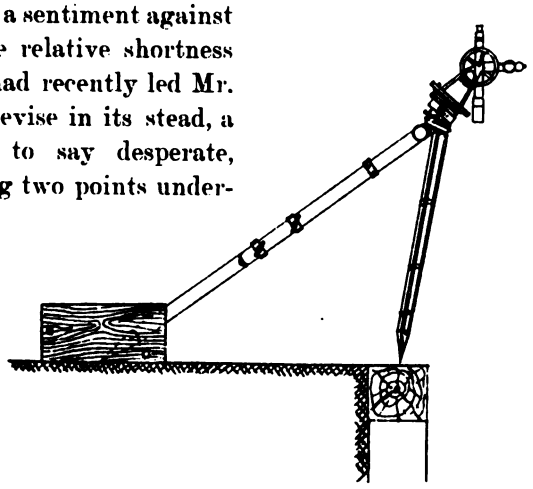


FIG. 25. THE MCFARLAN ALTERNATIVE METHOD.

* "The Connection of Underground and Surface Surveys," by Mr. G. R. Thompson, *Trans. Inst. M.E.*, 1901, vol. xxii., page 526.

† "Carrying the Surface Meridian down a Vertical Shaft," by Mr. George C. McFarlan, *The Engineering and Mining Journal* [New York], 1903, vol. lxxv., page 749.

tightly clamped between two [150 pounds] cast-iron blocks." The levelling screws were then worked to their limit in opposite directions, until the main telescope swung 2 degrees beyond the nadir. A direction-line was then established at the bottom, which "checked to the minute" with that previously located by use of the solar-auxiliary. Having no striding level, the instrument was previously set in the alignment or meridian crossing the shaft and a truly vertical line, struck upon a wall, near by, lying between two horizontal lines in the form of a prostrate letter H. When the transit is tipped out of the normal position as directed, points are sighted successively upon the upper and lower horizontal lines, adjusting the instrument after each set of trial-observations, until the points so sighted are equidistant on the same side of, or coincident with, the vertical line. The axis of the main telescope will then be revolving horizontally.

Vertical Sighting and Optical Plumbing.

The opponents of the gravitational methods (disregarding the magnetic needle) have recourse only to the telescope. In the consideration of the telescopic methods, a distinction should be made between the mere establishment of a direction, as for straight-line tunnel-work, at the bottom of a shaft, by optical means, and the fixation of a nadir-point with a telescope adjusted to perfect verticality. This naturally divides the instruments, which have been devised to accomplish these ends, into two classes.

The instruments which should be classified under the first division of this general head are varied in number and design. They are best considered under five subdivisions, namely: the English excentric or cradle-theodolite; the German excentric, in which the main and only telescope is placed at the side of the instrument; the American excentric, in which the standards are inclined forward; the passage-instrument, without circles, but with a suitable opening in the base; and those instruments, of indiscriminate denomination, associated with the objective prism, which have been touched upon elsewhere in this paper. All of them aim at the establishment of a direction, an alignment, or a so-called meridian, at the bottom of a shaft, without special provision for limitation as to distance,

As Mr. G. D. Ridley has said,* "they wanted both a point and a direction," but we must consider that the determination of a point in a line, so transferred, is not so important in its influence upon the survey as the direction of the line itself. By the advocates of the optical methods it would be contended that one plumb-line may be used to fix a distance, but that two may not be used to fix a direction.

Mr. J. C. Bournes was the first to apply this method in England with the cradle-theodolite, about 1840. In shallow shafts, 20 to 25 feet in diameter, like those of the Great Western railway, this method could have been practised with the Sissons theodolite as early as 1723, if the occasion had been propitious and this expedient had suggested itself. Among the other instruments of this type suited to the performance of this work may be mentioned the Werner *scheibeninstrument* of 1765; the so-called "Lean dial" which Adams introduced in 1791; the Giuliani *catageolabium* of 1798; and the American top auxiliary telescope, which Petherick first used about 1856.

The continental excentric theodolite was first used in the German mines in 1834, and, in France, it had been associated with the name of Mr. Combes, since he introduced it there in 1836. It was the prototype of the American side auxiliary telescope, which Mr. Hulbert first used in 1856. Since that date, it had been considerably used for the establishment of the meridian-line in vertical shafts. Mr. Hulbert attempted optical plumbing with it, arguing that if the graduations of a vertical circle were trusted to indicate any observed angle of inclination, there was no reason why it should not point to the nadir when adjusted to 90 degrees on the vernier. Relatively speaking, this seemed logical, but, obviously, any slight error in setting would be proportionally accentuated with each succeeding foot in depth.

In 1854, the American excentric transit was first used by Mr. Alex. Roberts for the pursuit of the Bournes method. In 1882, Mr. Henry Blattner, of St. Louis, Missouri, took out a patent upon a proposal to mount the standards, in journals beneath the plates, so that the instrument could be used as a concentric or an excentric type, as desired. In 1883, Mr. R. Gibbons of Alameda, California, sought to accomplish the same results by

* *Trans. Inst. M.E.*, 1901, vol. xxii., page 559.

slightly different mechanical means, in mounting the forward truss legs only, in bearings, above the plates, regulating the height of the rear legs by clamping to a specially provided arc. A considerable amount of experimentation had been conducted along these lines for several years previously, with the view of adapting the concentric standards to situations where excentricity was required, but no mechanic, the writer believes, has ever been able to construct such a model that could be justly denominated as anything but a freak.

Contemporaneously, the transit with duplex bearings came into existence. In this model, a second set of bearings, overhanging the edge of the plates, were bracketted to the regular style of standards, but this necessitated additional weight, exposed parts, and complications that militated against its popularity.

Touching incidentally upon Mr. A. Beanland's wellknown method of 1856, and the subsequent modifications of Messrs. Charles Richardson and J. J. Geach in the Severn tunnel during 1880,* as also that of Prof. E. H. Liveing in 1899,† it was interesting to note that, in 1877, Mr. G. H. Crafts used a passage-instrument with a horse-shoe base in the shafts, 140 feet deep, of the Dorchester Bay sewer, near Boston, Massachusetts.

It was easier to discriminate between the methods than between the instruments that came under this general classification, but the ten or twelve now to be considered, under the second subdivision, were supposed to be those originally intended for the projection of points in the nadir, or for erection directly above such points already established.

In 1824, Mr. F. R. Hassler, then superintendent of the United States Coast Survey, published in Philadelphia a description of the nadir-apparatus, which he used primarily for base-line measurements, although it had ever since been successfully used in plumbing from triangulation-towers, 20 to 150 feet high.

Between 1791 and 1797, Mr. Hassler had assisted Mr. Tralles, afterwards member of the Berlin Academy, in the measurement of a base-line in Switzerland some 42,000 feet long. It was

* *Engineering*, London, 1882, vol. xxxiii., page 48.

† "Underground Surveys and their Connexion with the Surface by the Transit Method," by Prof. E. H. Liveing, *Trans. Inst. M.E.*, 1899, vol. xviii., page 65.

measured with a chain, similar to that made by Ramsden, and also with an iron T-beam, 4 toises in length.* For the exact demarcation of the ends of the rods, in the several successive settings, Mr. Hassler designed a pair of nadir-telescopes, one of which is shown in Fig. 26. The photograph is reproduced here through the courtesy of the officials connected with the United States Coast and Geodetic Survey, who have no reason to doubt that it is one of the original set. They were centred by the four opposing thumb-screws, which appear conspicuously, while in the model made for the Spanish General Ibañez, by Brunner, of Paris, a centreing base similar to the Stanley mechanical stage (Figs. 32 and 33) was used. In the Hassler model, the upper flange of the telescope-barrel extends outward at one side, forming a small bracket. Upon this rests a level vial, 60 millimetres in length, 11 millimetres in diameter, and graduated with lines 2 millimetres apart, which have an angular value of 16 seconds. The telescope is not only revolvable, in its outer casing, but exchangeable with a second cylindrical barrel, which may be seen lying to the right and beneath the instrument. Into this, in turn, fits a long slender spindle, with a plummet-point that is used to punch the centre-mark at the top of an observation-tower directly above the station in the ground.

In 1877, Prof. A. Nagel, of Dresden, introduced a special theodolite, without an azimuth-axis, but with an extra large vertical axis, with a perforation, for optical plumbing in the mines near Zwickau.† The writer has touched upon this instrument in his first paper communicated to the American Institute of Mining Engineers, but, at the risk of incurring the criticism due to a transcriber, he would venture a few more remarks which have been taken mainly from Mr. Brathuhn's *Markscheidekunst*. Prof. Nagel's instrument was provided with a striding-level, having a sensibility of 6 seconds for each division, and another bubble set at right angles to this, across the axis of the telescope, which had a sensibility of 7 seconds for each division. In order to adjust the optical axis of the telescope to true verticality he occasionally used, instead of the bubbles, a mercurial horizon.

* *Der Basisapparat des Gral. Ibañez*, by Dr. C. Koppe, Nordhausen, 1881.

† *Trans. Inst. M.E.*, 1901, vol. xxii., page 559.

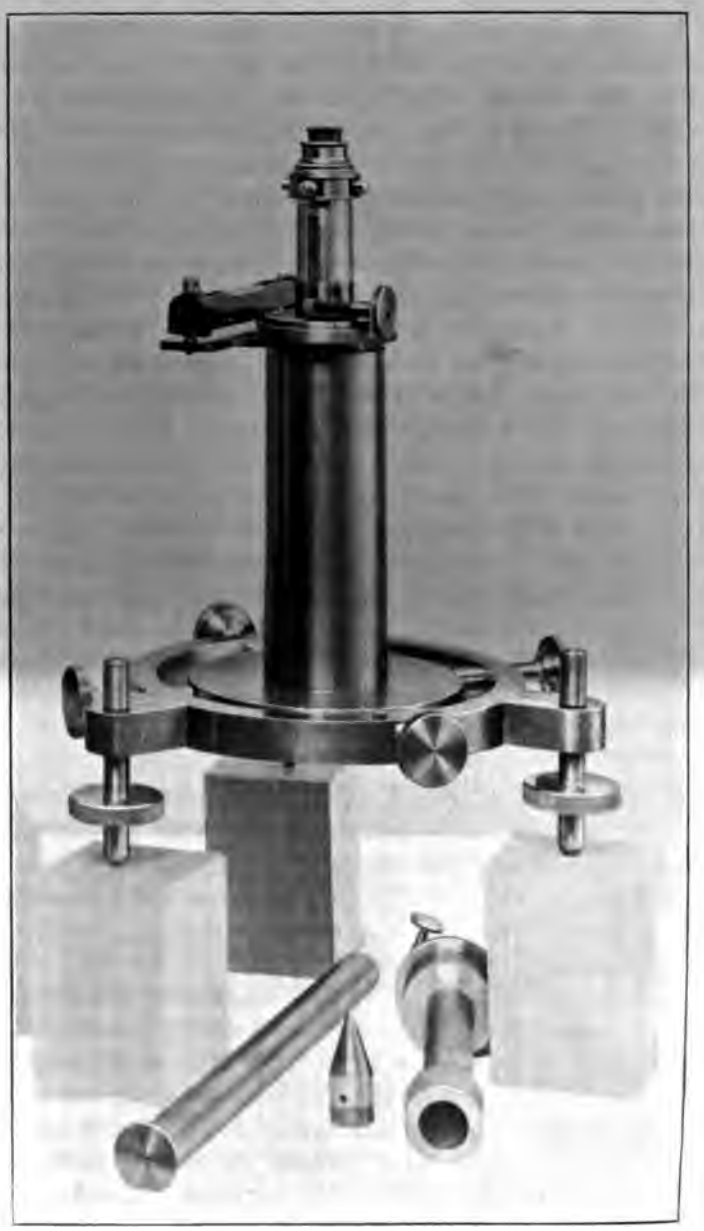


FIG. 26.—THE HASSLER NADIR-APPARATUS, AS USED IN THE UNITED STATES COAST AND GEODETIC SURVEY.

hich he set beneath the instrument, and fixed the cross-webs on the image of their own reflection upon its surface. He eferred, however, to use the bubbles entirely, as in practice found that the results were just as reliable and the use of e artificial horizon for this purpose was attended with tedium d inconvenience. The instrument was centred over each of o points, in the meridian-line traversing the mouth of the aft, by means of a spill, similar to that just described in conction with the Hassler instrument, and their respective posins projected to the bottom of the shaft upon two micrometertes such as those shown in Fig. 27. Prof. Nagel's experiits were conducted in a shaft 132 metres deep, where he found one double observation, g only the bubbles, an of 0·6 millimetre, and nother case an average e double observations equal to 0·27 millie, indicating an angur of about 40 seconds points were 6 feet

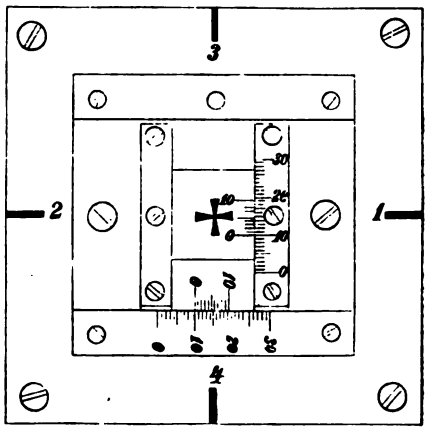


FIG. 27.—THE NAGEL CENTREING APPARATUS.

r. Suski, of Kladno, a trial of this method, haft 520 metres deep, o stages. He doubtcould not see the n by a single sight from the surface, and was obliged onstruct an intermediate station. His axial bubbles had nsibility of 1 second for each division, but he found an aver- error of 0·557 millimetre in five sets of observations.

The accuracy of this method depends upon the possibility of usting the optical axis so that it will project points in the ct nadir for all distances. When the length of the telescope ompared with that of the shaft, this will appear a very diffit performance, except by double reversed observation, for the ermination of a mean, in which case it possesses no special antage over swinging plumb-lines against co-ordinate scales. deeper the shaft, the greater the divergent error, the more itive must be the bubbles, the more powerful the telescope,

and the more apparent the objection which characterizes all operations of this kind, for whatever purpose—the decreasing transparency of the air.

In 1885, Messrs. Troughton and Simms introduced a prismatic nadir mining dial of peculiar construction, with a perforation, $\frac{5}{8}$ inch in diameter, through its single axis of revolution.

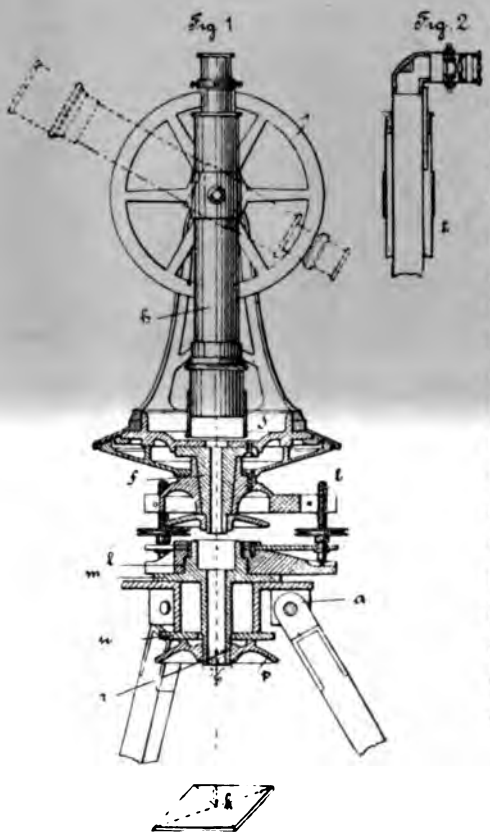


FIG. 28.—THE DENNERT-PAPE NADIR-THEODOLITE, 1888.

In 1885 also, Messrs. T. Cooke & Sons, of York, introduced a concentric theodolite of the usual pattern, with a perforation, $\frac{3}{8}$ inch in diameter, through its compound axis for nadir sighting. The horizontal circle was 7 inches in diameter, and the vertical circle, 9 inches, each being provided with three verniers. This was the first nadir theodolite of which the writer had any knowledge as actually existing. He noted, however, that Mr. Hosko[illegible]old claimed to have thought of such a device in 18[illegible]70.

In 1887, Mr. E. A. Geisler, of the United States Army Engineers, designed a nadir-transit, in which the compound axis of the ordinary transit-theodolite was slightly increased in diameter, and pierced with a hole, $\frac{3}{32}$ inch in diameter. For surface-work, in broad daylight, so small an opening might answer, but for plumbing shafts, the orifice should not be less than the diameter

of the objective, except at the sacrifice of light—a *sine quâ non* in mining operations.

Following the experiments of Prof. Nagel, a sentiment sprang up in Germany in favour of optical plumbing for general land-surveying, which induced Messrs. Dennert & Pape, Fennel, and Randhagen to introduce, by a curious coincidence all in the same year, 1888, three instruments which will now be considered. Each mechanic worked independently of the other, producing instruments originally intended for rapid setting up in the wind over surface-points, though not impossible for use in plumbing shallow vertical shafts. The instrument shown in Fig. 28 was designed by Messrs. Dennert & Pape, of Altona.* The instrument is centred over any point, *k*, by turning the telescope with the objective downward and sighting through the hollow axis, *f*. For this purpose, a vertical hole is also bored through the shifting base, *l*, which may be moved about laterally on the tripod-head and clamped to any position by the hand-nut, *p*. In the bottom of the orifice may be screwed a plug with a hook for the plummet, if the mechanical method is preferred. When the instrument is carefully levelled, and the telescope brought to a vertical position by setting the vernier of the vertical circle at 90 degrees, the telescope-cap is pulled out and the sight taken. To prove the verticality of the telescope, so adjusted, the whole instrument should be turned one revolution upon the vertical axis, and in no part of it should the cross-webs leave the point, *k*. For greater convenience in making such a sight a broken ocular is supplied; but this is so inconvenient for general use that the writer was led to suggest for such a purpose the enlargement of one side of the horizontal axis, for the reception of a second ocular, and the introduction of a removable prism at the centre of the telescope after the style of the "broken telescope."

Mr. Adolf Fennel, of Cassel, has indeed utilized this principle in the very interesting manner shown in Fig. 29. The section conveys so comprehensive an idea of the construction that little description is necessary. An achromatic objective is set, and fully protected, in the lower end of the hollow axis. At the upper opening, between the standards, and at the focal plane

* *Zeitschrift für Vermessungswesen*, 1890, vol. xix., page 270.

of the objective, is set a reticule at f, which is adjusted by the capstan-head screws, x and y, so that the cross-webs shall coincide with the optical axis of the broken telescope. Just above, is a round socket, into which is set a broken or bent tube containing the reflecting prism and inverting ocular. The centre-line of the removable ocular-tube is coincident with the bent ray, as deflected from the prism. The ocular is focussed by sliding in and out. In the first form constructed, while experimenting upon this design, Mr. Fennel placed the prism between the objective and the cross-hairs, necessitating the use of an erecting

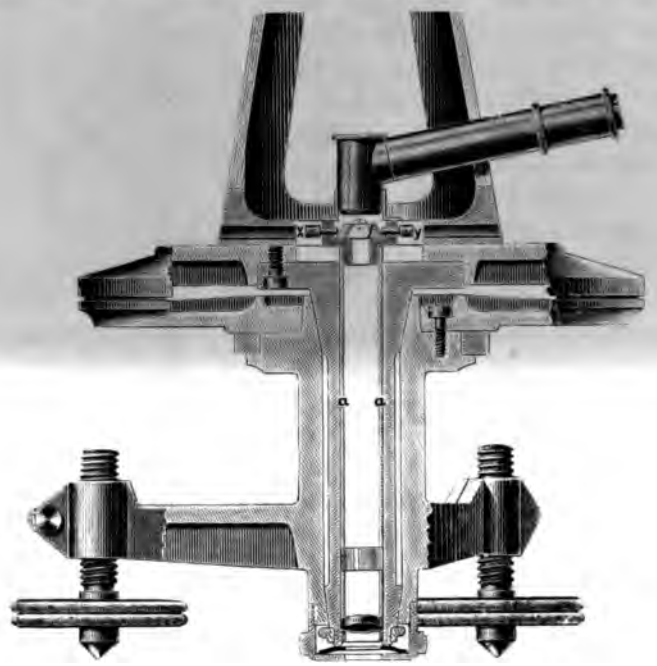


FIG. 29.—THE FENNEL NADIR-THEODOLITE, 1888.

ocular, but it was so impossible to maintain the adjustment of collimation, so that the extensible movement of the eye-tube should always be parallel to the divergent ray, that he placed the cross-webs and objective in permanent relationship at the upper and lower ends of the hollow axis. The introduction of this apparatus increases the height of the theodolite by about 20 millimetres but as it is applicable only to theodolites having circles 20 centimetres or larger in diameter, this additional height is not noticeable.

Mr. Randhagen, of Hanover, applied the principle to a simple excentric theodolite, with but a single axis of revolution (Fig. 30). This instrument had an ordinary base with three levelling-screws set into the rivulets of a three-armed support, A, A and A, which in turn was free to move from 5 to 10 centimetres laterally upon an old-fashioned wooden tripod-head nearly the size of a plane-table. By this movement, while sighting down through the line, CH, the instrument could be centred over the bolt, H, which must be imagined at a considerable distance beneath the position

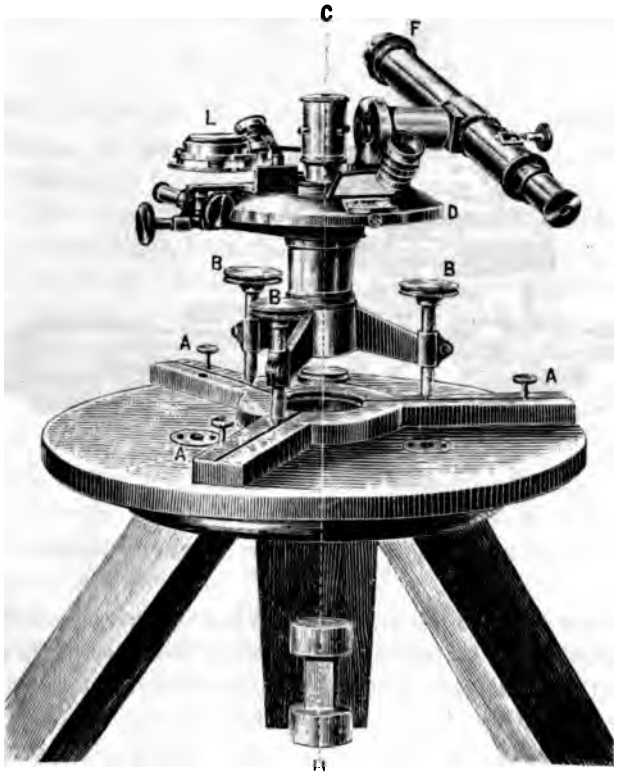


FIG. 30. THE RANDHAGEN NADIR-THEODOLITE, 1888.

given it in the engraving. In this instrument, the vertical centreing telescope could be pulled upward and out of its socket, and a spill, as used by Mr. Hassler, inserted in its stead. This one, however, projected upward for some distance, in accordance with Dr. W. Jordan's idea, to serve as a signal or sight for other theodolites at other stations in the polygon. Two or three such

ments have been much used, at one and the same time,
y-surveying.

In 1886,* Mr. Hildebrand was probably the first to recon-
uct the design, and greatly reduce the size, of the Nagel
paratus, adapting it for use in general engineering practice.
his instrument is shown mounted upon a geodetic tripod in
r. W. Jordan's *Vermessungskunde*,† where it is stated that the
ripod-head should have a central hole, about 5 centimetres in

FIG. 31.—THE NAGEL-HILDEBRAND APPARATUS (1886) ADAPTED FOR USE IN MINES.

diameter, over which may be placed a three-cornered bras
plate that has attached to it, from beneath, a brass tub
When this had been shifted about, and finally clamped direct
above the station, the centreing telescope was removed, and th
theodolite put in its place. Recently, this apparatus has bee
slightly changed in design only, by a spherical enlargement o
the objective-end of the telescope, which fits into the centra
capsule of the Freiberg *untersatz*, as previously explained in co
nection with Fig. 6. In this way, it is convenient for use in a
ordinary mine-surveying traverse, where the instrument is t
be set up over points in the floor. Fig. 31 shows that three sma

* *Der Civilingenieur*, 1886, page .

† Stuttgart, fifth edition, 1897, page 393.

y have been added to the *untersatz*, to receive the crews of this diminutive plumbing-apparatus. In Fig. *ersatz*, or tribrach, is shewn mounted upon the Borchers shewn in the miniature cut, *a'*, Fig. 5. It is moved n the surface of the plate until centred, when it is y the set-screw shown beneath. The thumb-screw ule is then released, the plumbing-telescope removed, gnal-target (Fig. 5) set up on the *untersatz*, with the *v*, in the gutter of the nut shewn in the immediate . The theodolite itself may also be replaced in this

)-1871, while Dr. W. Jordan was conducting geodetic Baden, he set a small telescope, horizontally, just d outside the tripod-head. In the lower prolongation s of the theodolite, he placed a 45 degrees reflector, ed a ray of light, from the station-point, at right angles nall telescope. In this way, he was enabled to centre ient accurately in high winds, but for various reasons ied this device in 1884 for one quite similar to Mr. r's, except that it had no circles.

. F. Stanley, London, did not bring out a nadir until 1892, for shaft-work in the construction of id railways. Among the many instruments made by hat date was one of special form introduced in 1899* l mine, railway and tunnel work. It had a clear erture, 2⅜ inches in diameter, providing a telescopic) degrees on either side of the vertical. In addition al sliding-leg adjustment of the tripod, the centres al displacement of 1¼ inches.†

cently, Mr. W. F. Stanley has brought out a second his class (Figs. 32 and 33), with which have been he writer's interchangeable auxiliary telescope and the echanical stage, introduced in 1888, adapting it o a wider range of general mine-surveying than is ith any other single instrument yet devised. The stage is so contrived that after the instrument has

ctions of the American Institute of Mining Engineers, 1901, vol. xxxi.,

ing and Levelling Instruments, by Mr. W. F. Stanley, London, 1901, page 330.

been once levelled a centreing movement may be induced without destroying this adjustment. It would be quite useless and impossible to give a detailed description of this composite instrument. Mr. W. F. Stanley furnishes the hollow axis and this style of auxiliary telescope with any size or pattern of his mining theodolite. In this type, the auxiliary telescope will not be so much used for nadir-projections as the main telescope; but for conducting surveys on steeply inclined planes, say, between 64 and 86 degrees, the interchangeable auxiliary telescope will be appreciated as no other device can be. For the observation of very precipitous horizontal angles and for the preservation of the shaft's alignment, it will be habitually applied to the top of the instrument. To read vertical angles below or above the normal range of the main telescope it will be attached at the side, and in neither instance will corrections for excentricity be necessary. It is only demanded that in each case the corresponding spider-line in the auxiliary telescope shall be made to revolve in the same plane with the one in the main telescope, by using the adjusting-screws provided.

FIG. 32.—THE SCOTT-STANLEY NADIR MINING THEODOLITE.

This is the class of instruments that Mr. H. D. Hoskold pronounced to be "clumsy, inconvenient, unsightly, and expensive, and subject to lateral vibrations," but they do not seem to be so generally regarded by fairminded men, who are willing to formulate estimates upon purely technical grounds. The auxiliary

cope has now been in use in America and elsewhere for riod of forty-eight years. Up to 1896, when the writer duced the interchangeable feature in its construction, liary telescopes had either permanently at the top or at the of the instrument. ither case, the possi- y of lateral vibrations never been considered hy of argument. The concern has been to with the parallelism e optical axes. If this l not have been guar- d, for all distances, whole plan of their y would have become loxical.

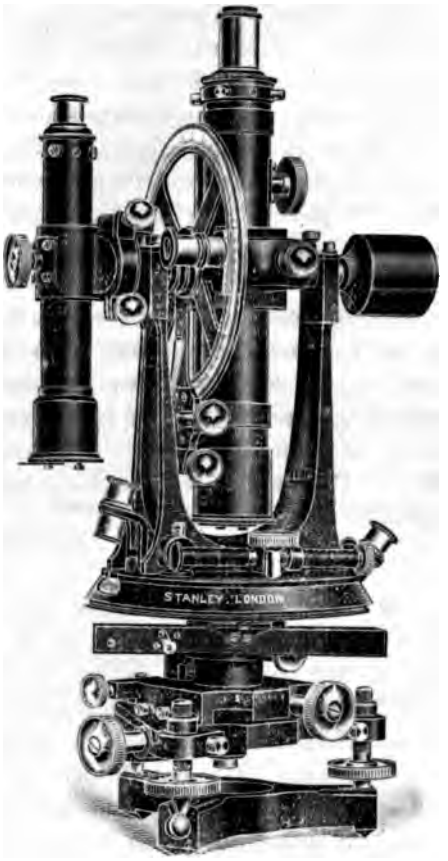


FIG. 33.—THE SCOTT-STANLEY NADIR MINING THEODOLITE.

'ith the instrument described, a direction be established at the m of a shaft with the telescope through the w vertical axis or with auxiliary telescope, rably attached to the f the instrument. As plumb-wire must be own in this line, so lished, to fix the nce, there will always be those who prefer to suspend the d wire and so dispense with vertical sighting in whatever it may be proposed. There will always be conditions, too, coast shafts where steam, smoke, gases and foul air rise in e volumes, that would preclude this alternative.

Ir. F. W. Simms* stated that "some attempts have been

* *Practical Tunnelling*, by Mr. Frederick Walter Simms. London, 1844, page cond edition, revised by Mr. W. D. Haskoll, 1859, page 36; third edition, l by Mr. D. Kinnear Clark, 1877, page 40; fourth edition, revised by Mr. inear Clark, 1896, page 40.

made to range the lines below by means of the transit-instrument itself; for which purpose it was placed over the shaft, and having been correctly adjusted to position, etc., by some such means as have been previously described, the telescope was turned vertically downwards, whereby the observer (by standing over the instrument) might look down the shaft (the base of the stand being made open for that purpose); and thus it was supposed that he might range a line, a wire, lights, enamel discs, or any other of the many contrivances which have been suggested for that purpose. Such methods are pretty in theory, but in practice not very likely to answer; for independent of the difficulty of thus accomplishing the required object, much time would be consumed, and the result not so satisfactorily arrived at as by the method of dropping the [plumb-] lines from the ranging-frames; and less advantageous, both as to expedition and certainty, than the method by the ranging spikes adopted at Saltwood, as before described." As this book was published in 1844, Mr. A. Beanlands could not have been the first to use the transit method described by him.*

Mr. Bennett H. Brough considered that mine-surveyors were greatly indebted to Mr. Scott for this valuable addition to his former paper, and for his erudite research into the origin and history of the three-tripod system of surveying, the objective prism, the solar attachment, the magnetic needle, and the plumbing of shafts. He had thrown much fresh light on a number of controversial points, and had clearly proved the practical value of a knowledge of forgotten inventions. Being largely a reply to criticisms on his earlier essay, the paper was a difficult one to discuss, although there must naturally be slight differences of opinion regarding some of Mr. Scott's views. With regard to the magnetic needle, the general use of iron and steel underground and the increasing adoption of electric appliances in mines had undoubtedly lessened its field of usefulness. Still, the remarkable achievements in compass-surveying in the past should not be forgotten. In the great monograph on the coal-mines of the Lower Rhine and Westphalia now in course of publication, Mr. Lenz recorded, for example, that in 1840 the

* "On Mining Surveys," *Trans. N.E. Inst.*, 1856, vol. iv., pages 267-270.

deep vertical Hercules shaft at Witten was sunk from a number of levels with accurate junctions, entirely from the results of a compass-survey. Indeed, it was not until June 9th, 1864, that the use of the theodolite was officially permitted in Westphalian collieries.

The CHAIRMAN (Mr. J. C. Cadman) moved a vote of thanks to Mr. Dunbar D. Scott for his interesting paper.

Mr. S. F. WALKER seconded the resolution, which was unanimously approved.

Mr. B. H. BROUGH moved a vote of thanks to the President and Council of the University of Birmingham for the use of the meeting-rooms, and to the owners of the various works in the district which were to be visited during the course of the meeting.

The CHAIRMAN (Mr. J. C. Cadman) seconded the motion, which was very warmly approved.

Mr. H. B. NASH moved a vote of thanks to the Committee of the South Staffordshire and East Worcestershire Institute of Mining Engineers and to Mr. Alexander Smith, for the admirable arrangements which had been made in connection with the meeting.

Mr. H. R. HEWITT seconded the motion, which was unanimously agreed to.

Mr. J. S. MARTIN (H.M. Inspector of Mines) moved a vote of thanks to Mr. J. C. Cadman for his services in the chair.

Mr. W. N. ATKINSON seconded the resolution, which was agreed to.

The following notes record some of the features of interest seen by visitors to works, etc., which were, by kind permission of the owners, open for inspection during the course of the meeting on September 14th, 15th and 16th, 1904:—

THE EARL OF DUDLEY'S ROUND OAK IRON- AND STEEL-WORKS.

These works comprize iron-works for the manufacture of high-class bar-iron; chain-works for the manufacture of chain; and steel-works for the manufacture of Siemens-Martin steel in bars of every variety of section.

Iron-works.—The iron-works were erected some 50 years ago by the late Earl of Dudley, for the manufacture of bar-iron from minerals raised on his own estates, and have continued in operation ever since. The works contain four bar or merchant mills, namely, a 16 inches mill, a 12 inches mill, an 8 inches mill and a 7 inches mill, and a very complete forge for the manufacture of puddled iron.

Chain-works.—The chain-works commenced operation about 15 years ago, for the manufacture of high-class chain for the Government, and chains have been supplied to the British Admiralty from the commencement up to the present time. Every size of chain is produced in these works, from $\frac{1}{8}$ inch up to $4\frac{1}{2}$ inches.

Steel-works.—The steel-works, commenced some nine or ten years ago, comprize five large open-hearth-steel melting-furnaces, standing in a shop, 350 feet long by 90 feet wide. A powerful electrically-driven overhead travelling-crane covers the whole area of the shop. This crane is fitted with two independent hoisting crabs, one capable of dealing with a load of 50 tons, and the other with a load of 12 tons; it is also fitted with a controlling cage at either end, containing a complete duplicate set of controllers.

The steel melting-furnaces are supplied with molten iron, brought by a locomotive direct from the blast-furnaces in ladles of large capacity, and poured direct into the furnaces, by means of an overhead crane: thus accelerating the process of steel-making.

The Bertrand-Theil process of making steel consists in partially converting the molten iron in the primary furnace, and in completing the process of conversion in the secondary furnace. By this means a very high quality of steel is produced.

A large metal mixer, or storage-furnace, is in process of astruction, and, when complete, it will hold, ready for mediate use, 200 tons of molten iron. On the charging plat-:m, in front of the Siemens furnaces, an electrical charging-achine of American design is installed for putting in auto-atically all cold material that is required in the process of el-making.

The ingots produced in this shop are transferred by cranes, ile hot, to a horizontal hydraulic charging-machine, which posits them in one of the heating furnaces (of which there are eral arranged in a circle); and the same machine is used to thdraw the ingots from the furnaces, and to pass them by ans of live rollers to the cogging-mill. This mill, with ls, 32 inches in diameter and 8 feet long, driven by a high-ssure reversing engine, with cylinders 42 inches in diameter 5 feet stroke, rolls the ingot into a bloom of suitable pe for the finishing-mill, which is placed directly in advance the cogging-mill at a distance of some 200 feet. The bloom m the cogging-mill, after passing through powerful shears, ich remove the ragged scrap-ends, is conveyed by means of rolls to the finishing-mill, where it is rolled into the finished or section. This mill has rolls varying from 28 to 32 inches liameter, 7 feet long, and is also driven by a reversing engine similar design to the cogging-mill engine. As the finished leaves this mill, it is cut to the required lengths by means saws, and after cooling and straightening, the bars are ready the market.

The bars produced in this mill consist of: Rounds in all s, from 2 to 8 inches in diameter; squares from 2 to 5 inches; s from 6 to 18¼ inches wide; channels from 6 inches by 3 hes to 15 inches by 4 inches; girders from 6 inches by 3 hes to 18 inches by 7 inches; tees; and a variety of special tions.

There are numerous electrically-driven appliances in these ks, such as cold saws, straightening machines, drilling and ching machines, etc.; an electric generating-plant driven a compound high-speed engine; a large battery of Lanca-re boilers; and hydraulic pumps and an accumulator.

SIR ALFRED HICKMAN'S IRON- AND STEEL-WORKS.

The Staffordshire steel and ingot iron-works are situated some 2½ miles from Wolverhampton, connected by sidings with the main line of the London and North-Western, and Great Western railways, and have also extensive wharfage on the Birmingham canal. The premises, including the adjacent collieries and brick-works, cover an area of some 200 acres, and are traversed by about 10 miles of railway and tram-lines.

The iron-ore, partly obtained from the Astrop mines in Northamptonshire, is discharged into hoppers, whence it is transferred into barrows for transport to the blast-furnaces.

There are six blast-furnaces 60 feet in height, thirteen large stoves, and five blowing-engines varying from 100 to 400 horse-power. Three furnaces are making basic pig, and a similar number of kilns are employed in calcining the ore. The output of pig-iron averages 2,000 tons per week, and is partly used in the steel-works.

The Bessemer-process plant comprizes three converters, with an out-turn capacity of 1,500 tons of steel ingots per week. The converters are supplied with blast by two powerful blowing-engines, and connected therewith are large cranes worked by hydraulic pressure.

There is a complete Moore plant of ballast-moulding machines, for the manufacture of ballast used in railway construction and maintenance.

There are four reheating-furnaces, a new type of the Siemens regenerating apparatus, cogging-mills, fitted with hydraulic gear, and a tilting attachment driven by an engine. The 24 inches bar-mill rolls large sections in bar, up to 16 inches in flats, 8 inches in rounds, and 8 inches by 8 inches in angles. The plate-rolling mills are furnished with plant, producing plates of the largest size for engineering and constructive works, some of these measuring 6 feet in width and weighing up to 3 tons. The 15 inches bar-mills, used for rolling small sections, and the 24 inches mill, are driven by an engine of 690 horsepower combined: the plate-mills by an engine of 600 horsepower; cogging-mills, 560 horsepower; blowing-engine, 500 horsepower; and hot shears, 150 horsepower. The steam for the engines is generated by two batteries of 17 large boilers, 30 feet long by 8½ feet in diameter, partly fired by the waste-gases from the furnaces.

The works are lighted throughout by electricity, the dynamos being driven by a compound condensing engine of 350 horse-power.

The grinding-works reduce the basic slag to the consistency of fine-grade flour, from 85 to 90 per cent. being fine meal, passing through a sieve of 10,000 holes to the square inch.

A steel-mixer has recently been erected for receiving the hot metal from the blast-furnaces, prior to its being used in the converters.

The blast-furnace gases are used for driving three Premier tandem gas-engines, each of 320 horsepower, driving three generators of 150 kilowatts; a blowing-engine of 550 horse-power with two gas- and two air-cylinders; a Premier blowing-engine of 1,000 horsepower; and a Westgarth blowing-engine of 800 horsepower.

SANDWELL PARK COLLIERY.

After considerable discussion as to the probability of the Coal-measures existing beyond the so-called eastern boundary-fault of the South Staffordshire coal-field, a sinking was commenced at Sandwell Park colliery some 30 years ago, and after encountering numerous difficulties the Thick coal-seam was struck at a depth of 1,260 feet. This discovery had been of enormous importance to the district, and had indirectly led to further developments.

The colliery is fitted with machinery and appliances arranged for an output of 2,000 tons a day; and at the present time a new sinking is being made to develop the estate still further.

HAMSTEAD COLLIERY.

Hamstead colliery is situated 4¼ miles north-west of Birmingham. The workings are bounded on the western side by the eastern boundary fault of the South Staffordshire coal-field, separating it from the West Bromwich coal-field, and on the east by an unproved fault.

The shafts were sunk in 1880. The Coal-measures were reached at a depth of 768 feet, and at 1,836 feet the top of the Thick coal-seam was reached. The seam is 24 feet thick in the shafts, but it thins northward.

The main roads are driven out to the boundary and the work is brought back. The system of working is that of "square work," the recognized method of working the Thick coal-seam throughout South Staffordshire.

In November, 1898, a fire occurred in one of the main roads, and the shafts were closed. In February, 1899, new roads were driven from the shafts in the Brooch coal-seam at a depth of 1,740 feet. These roads were driven about 1,500 feet, and were then inclined at an angle of 1 in 5 so as to meet the main roads in the Thick coal-seam. Dams were built in the road, which had taken fire, and the old roads and workings were recovered. The roads were found to be completely closed.

Owing to the depth and thickness of the coal-seam the pressure relieves itself by "bumps," which occur, from time to time, without any warning, shaking the roof and floor and sometimes knocking out the timber.

There are 17 Lancashire boilers, working at a pressure of 60 pounds per square inch.

The winding-engine has two cylinders 44 inches in diameter by 7 feet stroke. The drum is 22 feet in diameter, and is fitted with a steam-brake as well as a foot-brake. The condenser is worked by a beam-engine with a cylinder 31 inches in diameter.

The head-gear, constructed of wrought angle-iron and lattice-work, is 70 feet high. The cage has three decks, which are loaded and unloaded simultaneously: the full tubs from the top decks raising the empty tubs by means of drop-cages.

The winding-engine at the upcast pit has two cylinders, each 33 inches in diameter by 5 feet stroke.

The underground haulage, on the endless-rope system, is driven by three engines on the surface. There are also two endless ropes on the surface conveying the coal to the canal and landsale-wharf.

The Guibal fan, 36 feet in diameter and 12 feet wide, produces 80,000 cubic feet of air at 1½ inches water-gauge, when running at 45 revolutions per minute.

The bull pumping-engine, at the top of the upcast shaft, has

a cylinder 40 inches in diameter by 6 feet stroke. The lodge-room is 600 feet deep, and the water is forced through pipes 10½ inches in diameter by a ram 9 inches in diameter.

LANGLEY BORING.

This boring, on the Birmingham side of the eastern boundary fault of the coal-field, is being made by the New Calyx Boring Company's specially designed deep-boring installation, for the express purpose of obtaining a large core of the Thick coal-seam at a depth of about 1,400 feet: a previous boring (by another system) having failed to secure any core, although it proved the existence of the seam.

THE SOUTH WALES INSTITUTE OF ENGINEERS.

EXCURSION MEETING,
CARDIFF, SEPTEMBER 19TH TO 22ND, 1904.

A party of members of the Association des Ingénieurs sortis de l'École de Liége, who had attended the Annual General Meeting of The Institution of Mining Engineers, held in Birmingham on September 14th, 15th and 16th, 1904, paid a visit to South Wales. Excellent arrangements for their reception and entertainment were made by the South Wales Institute of Engineers, and by Mr. Maurice Deacon (on behalf of The Institution of Mining Engineers).

The following notes record some of the features of interest seen by the visitors to collieries, works, etc., which were, by kind permission of the owners, thrown open for inspection during the course of the excursion meeting.

DOWLAIS STEEL-WORKS, CARDIFF.

There are four compound condensing blast-engines, with high-pressure steam-cylinders, 36 inches in diameter by 60 inches stroke; low-pressure steam-cylinders, 64 inches in diameter by 60 inches stroke; and blast-cylinders, 88 inches in diameter by 60 inches stroke. Each engine can blow 30,000 cubic feet a minute, and deliver the blast at a pressure of from 4½ pounds to 12 pounds per square inch. Each engine, with a boiler-pressure of 100 pounds, develops about 1,500 horse-power.

The blast-enginehouse is 146 feet long, 32 feet wide and 60 feet high. Eight pumps supply water to the works. The capacity of the top-tank for the tuyères is 178,000 gallons; the tank on the hydraulic enginehouse, 90,000 gallons; and the bottom tanks, 80,000 gallons.

There are fifteen steel-boilers, each 8½ feet in diameter, 30 feet ong, and furnishing about 250 horsepower. The chimney is 240 feet high from the ground-level, and 278 feet from the bottom of the foundations: the inside diameter, at the top, being 13½ eet; and it is capable of working twenty-four boilers.

The four blast-furnaces are 75 feet high, the diameter of he boshes being 20 feet, and the diameter of the hearths 12 feet. Each furnace has eight tuyères.

There are eight hot-blast stoves, each 68 feet high and 24 eet in diameter, and having a heating surface of 47,500 superficial feet; and one hot-blast stove, 85 feet high and 24 feet in iameter.

There are three coke-bunkers, each having a capacity of 1,250 ons; twelve ore-bunkers, each having a capacity of 867 tons; nd four limestone-bunkers, each having a capacity of 850 tons.

The blast-furnaces, blast-enginehouse, and gantries are all uilt on piles, varying from 24 feet to 36 feet in length. The otal number of piles is about 1,800, the quantity of timber used n them being about 80,000 cubic feet.

The hearths of the blast-furnaces are 22 feet above grass-evel, and the ordinary rail-level of the works is 12 feet above he grass.

The steel-plant consists of a row of six large-sized Siemens-Martin smelting-furnaces, worked from self-charging producers, nd a 160 tons Talbot furnace. There is a fine slabbing-mill, nd a plate-mill that can make plates up to 100 inches wide in arge quantities.

BARRY DOCKS AND RAILWAYS.

These properties, belonging to the Barry Railway Company, consist of docks at Barry, a main line of railway from Barry to Hafod in the Rhondda valley, where it joins the Taff Vale ailway, Rhondda system; a branch from the main line joining he Taff Vale Company's main line at Treforest; a branch from Cadoxton to Cogan, where it joins the Taff Vale railway (Penarth branch); also branches from the main line, which join the Great Western, South Wales main line at Peterston and St. Fagans; an extension from Barry to Barry Island and a landing-pontoon at the dock-entrance; and railways from the main ine near St. Fagans joining the Walnut Tree and Aber branches

of the Rhymney railway-system near Caerphilly. The Vale of Glamorgan railway joins this company's main line at Barry, and forms junctions with the Great Western railway at Bridgend and with that company's Ogmore valley branch-line, and is worked by this company.

BUTE DOCKS, CARDIFF.

In the year 1830, the then Marquess of Bute, seeing the great advantages likely to accrue from the provision of increased dock-accommodation, particularly with regard to the development of the mineral wealth of the district, obtained an Act of Parliament for the construction of what is now known as the Bute west dock (but then termed the Bute ship-canal). Under this and an amending Act, passed in 1834, the Bute west dock and basin were constructed, with a cut or entrance from the Bristol channel.

To meet the requirements of the port, the trustees under the will of the Marquess of Bute (who had died in 1848) constructed, without parliamentary powers, the Bute east dock, upon land belonging to the Bute estate, a portion of which was opened on the 20th of July, 1855; and this was subsequently extended to its present dimensions. In 1856, the trustees provided a tidal harbour for the accommodation of the coasting-trade. The site of this harbour is now included in the Roath basin.

In 1866, an Act was obtained, authorizing the construction of the basin, known as the Roath basin, which was opened in the summer of 1874. In the session of 1882, the Roath dock was authorized, and was opened in August, 1887. In 1894, an Act was obtained authorizing the construction of the south dock, which was commenced in 1898, and will be opened in 1906.

The various Bute docks now consist of:—The Bute west dock, water-area of 19½ acres; the Bute east dock, water-area of 46¼ acres; the Roath basin, water-area of 12 acres; the Roath dock, water-area of 33 acres; and the south dock will have a water-area of 53 acres.

The entrance-channel, which is constructed through the East Mud, joining the river Taff at the Eastern Hollows, and continued through a shoal known as Cefn-y-wrach, is 400 feet in width at the narrowest part, and in other places is 600 feet in width.

The machinery and appliances of all kinds at the several docks are of the best construction and most improved designs. There may be noted, in particular, the Lewis-Hunter coaling-cranes; these cranes enable a vessel to load or discharge at three or more hatchways simultaneously, and are capable of loading a steamer of 7,000 tons burthen in 24 hours. By means of these cranes, the operation of shipping and unshipping can be carried on simultaneously, there being lines of railway under the cranes, parallel with the quay. Vessels carrying 9,414 tons of coal have been loaded by these cranes. Hydraulic power is extensively used for working these and other cranes and machinery.

PENARTH DOCKS.

The Penarth Docks of the Taff Vale Railway Company, are fitted with the most modern coal-shipping appliances, comprizing movable tips designed for, and capable of lifting, a 10 tons wagon 45 feet above the quay, tipping the contents into the shoot, and returning the wagon to the quay, within 30 seconds. The dock-gates and capstans are worked by hydraulic power; and the level of the water in the dock and basin is maintained by powerful centrifugal pumps.

AMMANFORD COLLIERY.

Two seams of anthracite-coal are worked by means of two slants. The hauling-engine, at the mouth of the No. 2 slant, has two cylinders, 24 inches in diameter, and is fitted with helical gearing. The ventilation is effected by a Walker fan, 27 feet in diameter by 8 feet in width. There are four Lancashire boilers, 30 feet long and 8 feet in diameter, burning small-pea coal with forced draught. The exhaust-steam is used to heat the feed-water. The coal is crushed and divided into twenty different sizes, some of which are washed. The underground hauling and pumping is performed by electricity.

BARGOED COLLIERY.

Two shafts, sunk to the steam coal-measures, intersect the Nine-feet seam at a depth of 1,884 feet, and the Brithdir seam at 600 feet.

The compound winding-engine, at the south pit, has two horizontal high-pressure cylinders, 32 inches in diameter, and two vertical low-pressure cylinders, placed directly below the cranks, 50 inches in diameter, and 6 feet stroke. The drum is of modified conical form, designed to facilitate rapid starting. The cages carry four trams containing in all nearly 6 tons of coal. The winding capacity is about 350 tons per hour.

The Hathorn-Davey pumping-engine deals with 38,000 gallons per hour in three lifts.

The air-compressor is of the King-Riedler type, with double vertical compound steam- and air-cylinders, and develops 1,000 horsepower, when running at a maximum speed of 80 revolutions per minute.

The ventilation is produced by a Walker fan, 30 feet in diameter and 9 feet wide, driven by a vertical cross-compound engine by means of cotton-ropes.

There are sixteen Babcock-and-Wilcox boilers capable of working at a pressure of 120 pounds per square inch, and the steam is superheated about 80° Fahr.

The screening-plant comprizes two revolving tipplers, and after the coal passes over the screens it is cleaned upon the picking-belts.

The electrical installation consists of a 300 horsepower horizontal compound engine, driving three dynamos providing power for lighting and for driving workshops, saw- and mortar-mills, various coal-creepers, and motors working screens. A 100 horsepower direct-coupled engine is used as a stand-by, and also provides the lighting at night.

CLYDACH VALE COLLIERY.

No. 1 pit is sunk 1,182 feet to the Six-feet seam, and 1,884 feet to the Coronation seam. The winding-engine has two cylinders, 42 inches in diameter and 6 feet stroke. The steam-pressure is 90 pounds per square inch. The rope-drum winding from the Six-feet seam has a diameter of 15 feet 10 inches, and from the other seam, a diameter of 20 feet 6 inches. The round steel-rope has a diameter of $1\frac{3}{4}$ inches, and the breaking strain is 120 tons.

No. 2 pit is 1,242 feet deep. The winding-engine has two cylinders, 40 inches in diameter and 6 feet stroke.

No. 3 pit is 1,884 feet deep. The winding-engine has two cylinders, 32 inches in diameter and 6 feet stroke. The conical drum has diameters of 16 feet and 18¼ feet respectively.

The Waddle ventilator has a diameter of 35 feet; and at 80 revolutions per minute, 370,000 cubic feet of air per minute are exhausted under a water-gauge of 3·5 inches.

GELLYCEIDRIM COLLIERY.

Five seams of anthracite coal are won by means of a drift, 4,500 feet in length, at an inclination of 1 in 7. The hauling-engine, with two cylinders, 22 inches in diameter and a stroke of 4 feet, drives a drum, 6 feet in diameter. There are four boilers, two Lancashire and two Cornish, working at a pressure of 80 pounds per square inch. The ventilation is effected by means of a Waddle fan, 30 feet in diameter.

The compound-condensing double-stage air-compressor has two steam-cylinders, 21 and 37 inches in diameter respectively; and two air-cylinders, 22 and 34 inches in diameter respectively, with a stroke of 4 feet. The air-pressure is 80 pounds per square inch. The compressed air is used for driving pumping and hauling machinery in the mine.

By means of screens and breaking machinery, the coal is divided into seven different sizes, the smaller of which are washed in a Sheppard washer.

GLAMORGAN COAL COMPANY, LIMITED: LLWYNYPIA COLLIERIES.

There are six shafts and one level at the Llwynypia collieries: Nos. 1, 2, 3 and 6 shafts are used for winding coal; No. 4 shaft for pumping purposes; and No. 5 is an air-shaft connected with the No. 3 pit, from which the No. 3 Rhondda seam (bituminous) is worked. No. 1 shaft is sunk to a depth of 1,110 feet, the diameter being 15 feet. No. 2 shaft is sunk to a depth of 1,500 feet, and is 18½ feet in diameter. No. 3 shaft is 324 feet in depth, and 12 feet in diameter. No. 6 shaft is the deepest, being sunk to a depth of 1,560 feet, and is 16 feet in diameter. All the

seams between, and including, the No. 2 Rhondda and Five-feet seams, are won and worked in the abovementioned level and shafts. The beds of fire-clay, underlying the Nos. 2 and 3 Rhondda seams, are also worked and converted into bricks at the colliery.

The power for the colliery is derived from 49 boilers, all on the surface: 29 being of the Lancashire type, 30 feet long and 8 feet in diameter, and 20 being Babcock-and-Wilcox standard pattern boilers. The waste-gases from the coke-ovens are utilized for firing sixteen of the boilers, coal being burnt in the others. The steam generated, representing about 10,800 horsepower, works air-compressors, winding-engines, hauling-engines, fans and pumps.

Electric current equivalent to 200 horsepower is drawn from the mains of the South Wales Electrical Power Company, and utilized for the brick-works, mortar-mill, engine-shop, smith's-shop, saw-mill and stables.

The surface and the underground-roads for about ¼ mile from the pit-bottom are lighted by electricity, generated at the colliery by a Crompton dynamo.

The ventilation of the steam-coal seams is effected at No. 6 pit by a Walker fan, 27 feet in diameter and 9 feet wide, rope-driven; and at 86 revolutions per minute it produces 297,000 cubic feet of air per minute at a water-gauge of 3·6 inches. This fan is driven by a compound condensing engine, supplied with steam at a pressure of 120 pounds per square inch. The diameter of the high-pressure cylinders is 24 inches. A Schiele fan, 15 feet in diameter, driven on the first motion by a horizontal engine, is kept as a stand-bye.

The house-coal seams are ventilated by a Guibal fan, 30 feet in diameter and 10 feet wide, producing 40,000 cubic feet of air per minute with a water-gauge of 1·5 inches.

The horizontal winding-engine, at the No. 1 pit, has two cylinders, each 36 inches in diameter and of 6 feet stroke; and the average steam-pressure is 80 pounds per square inch. The horizontal winding-engine, at the No. 2 pit, has two cylinders, each 34 inches in diameter and of 5½ feet stroke; and the average steam-pressure is 80 pounds per square inch. The diagonal winding-engine, at the No. 3 pit, has two cylinders, each 18 inches in diameter and of 3 feet stroke. The horizontal winding-

ngine, at the No. 6 pit, has two cylinders, each 30 inches in iameter and of 5 feet stroke. All the winding-engines, with he exception of that at the No. 3 pit, are fitted with Barclay ut-off gear.

The drainage is effected by means of seven ram-pumps in o. 3 pit, and two ram-pumps in No. 4 shaft; most of this water forced to the surface, and is used for condensing purposes.

There are large fitters', smiths', carpenters', pattern-making nd wagon-repairing shops, with brickworks, mortar-mill, kilns, rass-foundry, etc.

Four air-compressors, on the surface, with cylinders ranging rom 18 inches to 53 inches in diameter, supply compressed air ainly for underground haulage, and partly for pumping, boring nd coal-cutting.

There are in all about ninety haulage-engines, with cylinders anging from 7 inches to 22 inches in diameter. The majority are ortable engines, fitted to and running on the tram-roads and orked by compressed air; and there are seven, each of about 40 horsepower. On the main-roads, the main-and-tail systems, n some of the pits, are driven by ropes, carried down the shaft nd driven by engines on the surface; and in others, the engines re placed underground, and steam is carried in pipes down he shaft.

Sprays are used for damping the coal-dust in the steam-coal easures; and, as the water required for this is conveyed in ipes from the No. 3 Rhondda seam, the pressure is high and ives good results. Wrought-iron feed-pipes, 2 inches in iameter, are laid along all the main roads; and tanks are used n and around the coal-faces.

The screening and washing plant is capable of dealing with he entire output of the colliery. The large coal passes over the creens (the standard screens of the coal-field with parallel bars, $\frac{1}{8}$ inches apart) on to picking-belts, after which it reaches the ailway-wagon freed of all impurities. The small coal falling hrough the screen is elevated to the washery, where any dirt is ashed out; and it is then screened into nuts, beans, peas and uff. The coal from the No. 3 Rhondda seam is screened, the mall coal washed, and the large coal conveyed into grinders, here it is crushed; and both large and small coal is conveyed o the coke-ovens.

The coking-plant comprizes three batteries of 160 (60, 60 and 40) Coppée ovens. The bye-products are not extracted, but, as already stated, the gases are run under boilers and used for generating steam.

The brick-works are capable of turning out 10,000 bricks per day.

A large power-station, 117 feet long and 73 feet wide, built of bricks made at the colliery, provides space for engines and generators to supply 12,000 kilowatts. The first set, practically ready, includes a 1,600 kilowatts, three-phase current, 25 cycles per second, 2,000 volts, Lahmeyer generator. The cross-compound condensing engine was made by Messrs. Sulzer Brothers, of Winterthur. The steam, with a pressure at the stop-valve of 150 pounds per square inch, is superheated to a temperature of 482° Fahr. in an independently fired superheater. This set will supply electric current to the pits for haulage-purposes, and will take the place of the steam-plant now used for underground haulage; and it will also supply electric power for pumping water. Six electric haulage-engines, each of 220 brake-horse-power, are now being erected to replace steam-engines.

The safety-lamps are in part lead-locked and the remainder magnetic-locked.

In all the various operations, 4,000 persons find employment: and housing accommodation has, to a certain extent, been provided, the company having built over 400 cottages.

GWAUN-CAE-GURWEN COLLIERIES.

Two seams of anthracite-coal are won by means of pits, 690 feet deep. The inclination of the seams are 1 in 6, and both are worked on the longwall system.

The coal is screened, crushed in a breaking machine, and the smaller sizes are washed in a Sheppard washer.

HARRIS' DEEP NAVIGATION COLLIERIES.

The winding-engine has two vertical high-pressure cylinders, 54 inches in diameter by 7 feet stroke, coupled to a spiral drum, 30 feet in diameter. The Cornish pumping-engine, 100 inches in diameter and 10 feet stroke, has recently been replaced

by an electrical installation, and a three-throw ram-pump delivering 250 gallons per minute from a depth of 1,500 feet. A Schiele fan exhausts 230,000 to 250,000 cubic feet of air per minute under 3 inches of water-gauge. The underground haulage-plant is actuated by compressed air, at a pressure of 50 pounds per square inch.

TREDEGAR IRON AND COAL COMPANY'S COLLIERIES.

Pochin Colliery.—The recently installed pumping and haulage electric plant comprizes two Lancashire boilers, each 30 feet long and 8 feet in diameter, working at a pressure of 120 pounds per square inch; two horizontal long-stroke compound engines, each developing 250 indicated horsepower; two three-phase generators, each of 200 kilowatts capacity, driven by ropes; a main switchboard, with instruments and switches; the necessary shaft and underground three-core cables; three main-and-tail haulage-gears with 5 feet drums driven by three three-phase motors of 55 horsepower; two endless-rope haulage-gears, each with two rope-wheels 5 feet in diameter, driven by two three-phase motors of 55 horsepower; one set of three-throw pumps, with rams 5 inches in diameter and 7 inches stroke, for shaft-work, driven by a motor of 25 horsepower; one set of three-throw pumps, with rams 4 inches in diameter by 6 inches stroke, for in-bye work, driven by a motor of 5 horsepower; and a complete electric lighting-plant. The screening-plant is driven by a motor of 55 horsepower.

Ty Tryst Colliery.—The large electric haulage and pumping power-station comprizes six Lancashire boilers, each 30 feet long by 8½ feet in diameter, working at a pressure of 160 pounds per square inch; three horizontal long-stroke compound engines, each developing 350 indicated horsepower; three generators of the three-phase type; a single-phase generator of 100 kilowatts for electric lighting, driven by a compound condensing-engine; one main switchboard; one three-phase transformer; main and branch cables; six distributing switchboards; thirteen electric motors of the three-phase type: namely, two motors, each of 100 horsepower; two, each of 75 brake horsepower; four, each of 55 brake horsepower; two, each of 40 horsepower; two, each of

25 brake horsepower, and five, each of 5 brake horsepower; three main-and-tail haulage-gears; four converted main-and-tail haulage-gears; three sets of three-throw ram-pumps, with rams 9 inches in diameter by 15 inches stroke, for shaft-work; one set of similar pumps, with rams 5 inches in diameter by 7 inches stroke, for in-bye work; five sets of similar pumps, with rams 4 inches in diameter by 6 inches stroke, for in-bye work; and a bar coal-cutting machine driven by a motor of 25 horsepower.

CARDIFF CORPORATION ELECTRIC POWER-STATION.

The engine-room, 234 feet long, 60 feet wide and 56 feet high from floor-level, is lined with cream-coloured glazed bricks. At intervals along the side-walls, substantial piers, with semi-circular arches, are provided, upon which the rails for the crane are fixed.

The boiler-house, 234 feet long, 56 feet wide and 48 feet high, is placed on one side of the engine-room; and its walls, facing the boilers, are lined with cream-coloured glazed bricks. The octagonal chimney stack, 160 feet high, and situated at the front end of the building, is built of red brick.

Immediately at the side of and adjoining the boiler-house, there is a building running the full length of the boiler-house, into which coal-trucks are brought direct from the railway-siding connected to the Taff Vale railway. From this building, the coal can be tipped either into the bunkers above the boilers, or into the coal-storage below the level of the siding.

At one end of the boiler-house, and approached from the same, and immediately beneath the repair-shop and smithy, is the pump-room, fitted with twelve feed-pumps.

A large cooling-pond is provided for condensing purposes, the water being drawn from a fresh-water brook running along one side of the main building, and dividing the power-station from the tramcar depôt.

There are four engines, each of 500 horsepower, two of 1,600 horsepower each and two of 1,800 horsepower each. The engines are all of the inverted vertical cross-compound condensing type of heavy design, and work under a steam-pressure of 140 pounds

per square inch, at a speed of 100 revolutions per minute. Each engine is fitted with a condenser driven by side-levers from the crossheads. The air-pumps of the smaller sets are 25 inches in diameter and of 12 inches stroke. The condensers are of the injector-type, with suitable water-regulators. The engines are entirely enclosed, and forced lubrication is used for all parts, the oil-pumps being worked by eccentrics. The governors are of the quick-speed type, driven by ropes from the crank-shaft; and means are provided so that the speed can be altered up or down by hand, whilst the engines are running, the governing variation from no load to full load being 2½ per cent. The flywheels of the small sets are 16 feet in diameter, the rims weigh 14 tons, and the total weight of each wheel is 35 tons. The flywheels of the larger engines each weigh 75 tons.

There are four generators, each with an output of 300 kilowatts, capable of withstanding overloads of 25 per cent. for 2 hours and 50 per cent. for short periods, without sparking and without moving the brushes. They are of the multipolar type, and are mounted directly on the shafts of the engines, between the high and low-pressure cylinders. The generators work as compound-wound machines on tramway-loads, at a pressure of 500 to 550 volts; and as shunt-wound machines on lighting loads, at a pressure of 460 to 500 volts.

There are two generators, each of the revolving-field type and each capable of generating 1,000 kilowatts, at 6,600 volts three-phase, with a power-factor of 0·9. These alternators are mounted between the high-pressure and low-pressure cylinders; and, in addition to the alternator flywheel, there is the engine flywheel, weighing 75 tons, so that the revolving parts weigh over 100 tons. The alternators are excited from a dynamo, direct-coupled to a side-by-side compound high-speed engine: this set is rated at 100 kilowatts and is capable of generating 1,000 ampères at 100 volts. The full-load excitation of the main generators is 250 ampères.

There is also a motor-generator, consisting of a three-phase synchronous motor of 500 kilowatts, direct-coupled to a direct-current compound-wound generator of 500 kilowatts. The direct-current machine is started up as a motor, until synchronous speed is obtained, and then the alternator is parallelled with the other generators. This set is run when the load is not sufficient for the larger sets.

A motor-generator of 80 kilowatts works in conjunction with a battery of accumulators, and serves several purposes. It consists of two generators coupled together, with a flywheel between the machines, and mounted direct on a common bed-plate. The low-tension machine has a double-wound armature, with a commutator at each end. A motor-generator of 75 kilowatts is also used for the same purpose.

The battery of accumulators consists of 56 cells, with 31 plates in each. The cells consist of lead-lined wooden boxes, supported on oil-insulators. The capacity of the battery is 2,100 ampère-hours, when discharged at 210 ampères; 1,800 ampère-hours at 360 ampères; and 1,620 ampère-hours at 540 ampères.

The main direct-current switchboard is built directly into the wall at one end of the engine-room, and stands back in a recess, 42 feet wide. Immediately in front of the board, there is a clear space, 10 feet wide. The switchboard is of the standard Ferranti pattern, and consists of ten feeder-panels, each of 600 ampères capacity; two return-feeder panels, each of 1,500 ampères capacity; a positive booster-panel; a negative booster-panel; three panels for the motor-generator and battery; a Board-of-Trade panel; four 300 kilowatts generator-panels; two 900 kilowatts generator-panels; and four panels for controlling the supply of current for private and public lighting and power-purposes, each of these panels having a capacity of 1,000 ampères. At the front, there is a table standing out from the board, upon which the field-regulating and motor-starting switches are placed, the resistance being placed below the board. There are also four panels on the front of the table for controlling the works' motors, battery and regulating cells, *etc.* There are two independent sets of main omnibus-bars for controlling the traction and lighting loads. All the switches are designed for a current-density of 60 ampères per square inch of contact-area. Each panel is fitted with an automatic circuit-breaker of the Ferranti pattern, and the various instruments are of the edgewise pattern. There are three Weston type illuminated dial-voltmeters at each end of the board for lighting and traction-purposes. There is also an independent switchboard for controlling the lighting of the works.

Another switchboard, consisting of ten panels, controls the

whole of the lighting of the power-station and car-shed, and the power-supply. This board is also used for running the two motor-generators in parallel or on the battery, in several different ways.

The three-phase switchboard, with eleven operating panels, is placed in a room running the full length of the building, and directly overlooking the engine-room. The whole of the extra high-tension omnibus-bars and switches are contained in a room directly below this upper room, and the whole of the switch-gear is worked on the solenoid system. There are three main generator panels, one station-load panel, three panels controlling the motor-generator and four feeder-panels. There is also a small exciter switchboard, consisting of two machine-panels and a battery-panel; the idea being to excite off the battery for light loads or when the exciter is undergoing any repair. The main switches are all of the oil-break pattern, and consist of three single-pole switches, each independently controlled by a solenoid. These switches are guarded by isolating switches on either side, so that they can be repaired even when the feeders and the omnibus-bars are alive. The transformers controlling the various instruments and overload and reverse relays are each mounted in a separate cubicle. There is a set of hospital-bars running parallel with the main bars, so that any machine can be run on any feeder. Similar arrangements have been made at the main sub-station, so that the system can be separated into two parts if necessary.

The ultimate capacity of this station will be 15,000 kilowatts, and arrangements have been made for extensions to the switchboard.

The feeders are protected by suitable lightning arresters of the Wurts pattern.

In the boiler-house, there are sixteen Lancashire boilers, 30 feet long and 8 feet in diameter, working at a pressure of 150 pounds per square inch. At the rear end of each boiler, there is a superheater, so arranged that it can be easily moved for inspection, the steam in the meantime going direct to the main steam-range. At one end of the boiler-house, there is an economizer, consisting of 288 pipes, with electrically-driven scrapers, built into a bye-pass from the main flue. Another economizer, erected between Nos. 7 and 8 boilers, also contains 288 pipes. The stokers are of the coking type, with hoppers

supplied from the coal-bunkers above. The ash-conveyor is of the worm-type, working in a trench in front of the boilers, and independent of the blow-off trench. Three vertical direct-acting feed-pumps, fixed in the pump-room, are each capable of delivering 6,000 gallons of water per hour against a pressure of 160 pounds per square inch.

The main steam-pipes in the boiler-house are 18 inches and 14 inches in diameter respectively, and are coupled to each boiler by means of a branch-pipe, 7 inches in diameter, from which there is also a bypass-pipe, 7 inches in diameter, to the superheaters. The main pipes are coupled to suitable water-separators at each end of the boiler-house. Large expansion-bends are placed at intervals in the range. The main range in the engine-room consists of two pipes, 14 inches in diameter, supported by the central gangway. This range is coupled through water-separators, at either end of the boiler-house range, by pipes 14 inches in diameter. The water-separators are drained through steam-traps and the water is delivered into the main drain-pipe, and then runs back to the cooling-pond. A duplicate system of auxiliary steam pipes, 4 inches in diameter, is provided for the pumps, with water-separators and drain-pipes.

The blast-furnaces and steel-works of the Ebbw Vale Steel, Iron and Coal Company, Limited, were also thrown open for inspection.

THE PROBABILITY OF *ANKYLOSTOMA* BECOMING A PERMANENT INHABITANT OF OUR COAL-MINES, IN THE EVENT OF ITS INTRODUCTION.

Interim Report of the Committee, consisting of Dr. G. H. F. Nuttall (Chairman), Mr. G. P. Bidder (Secretary), Dr. A. E. Boycott, Dr. J. S. Haldane and Mr. A. E. Shipley.*

Summary.

There are many channels by which *Ankylostoma* might be introduced into British coal-mines. The conditions found underground in these mines are such that the worm would, in many cases, at any rate, probably become firmly established.

In view of the expense and difficulty of eradicating the worm from any mine in which it has become established, it is of the greatest importance that preventive measures should be undertaken without delay. Complete eradication does not yet appear to have been ever accomplished.

The necessary prevention is best accomplished by the provision of proper sanitary accommodation in the main roads underground and at the pit's mouth, by regulations to prevent pollution of the pit by human fæces, and by the establishment of a limited quarantine system for workpeople from infected areas, with compulsory notification of cases to the Home Office.

Importance of the Question.

The economic importance of *Ankylostoma* is very great. In many tropical countries it is one of the chief causes of death; thus, in Puerto Rico, more than one-fifth of all deaths are due to this worm-disease. In this country, the underground workings of mines afford the necessary tropical conditions of temperature, and in this way provide situations in which the worm is capable of flourishing. In the Westphalian coal-field, the disease became prominent about four years ago, and many cases of illness occurred. The number of men who were thus

* *Report of the Seventy-fourth Meeting of the British Association for the Advancement of Science held at Cambridge in August, 1904*, page 292.

incapacitated from work was observed to be increasing rapidly; in consequence, very extensive efforts have been made to stamp out the disease. Hospitals were built, a special staff of doctors provided, all the men were specially examined; those who were found to be infected were not allowed to work underground, and were all treated in the hospitals until they were free from the worm. It is impossible to state exactly even the direct expense of all these measures, but the figure certainly amounts to several hundred thousand pounds.

When it is remembered that 650,000 men are employed underground in the coal-mines of Great Britain, and that it has been found that in a badly infected mine 80 per cent. of the men may have the disease, the gravity of the question is apparent. By the incidence of such an epidemic both employers and workpeople must be seriously affected, not only in the measure of the number of men seriously ill, but also of the far greater number who have no obvious symptoms, but an impaired efficiency for work.

The sanitary arrangements in Westphalia have been carried out very thoroughly and energetically, but it has not been found possible completely to eradicate the worm. The number of infected men has been greatly reduced, but a small percentage remains of men who still harbour the worm. This small percentage remains about the same, in spite of the continuance of treatment; and is, of course, always capable of introducing the disease into any fresh mine, or of reinfecting the mine to any extent if preventive measures were relaxed.

Before considering the probability of the spread of *Ankylostoma* in this country, it is necessary to point out that we have hardly any definite information as to its complete absence at the present time. Only one case of the disease has been recorded in a British coal-mine, but the worm may well be present to a limited degree without causing obvious illness. A latent infection of this kind, owing to some small change in the temperature or the moisture of a mine, may increase to a serious epidemic at any time, or may be carried to other pits where more favourable conditions may lead to the most disastrous results. No evidence of the presence of the worm has been found in the few collieries which have been systematically examined, but it must not be assumed too readily that it is completely absent.

s there a Probability of *Ankylostoma* becoming Established in British Coal-mines?

(A) *Possible Sources of Infection.*—(1) The worm is endemic mong the general population in nearly all tropical and sub-opical countries (Southern Asia, Africa, South America, West ıdies, etc.) and parts of North America, Australia, and in urope south of the Alps, and in Hungary. (2) It is present mong underground workers in the Westphalian coal-field and ı the French and Belgian coal-mines. (3) It is present in the ornish tin-mines, at any rate in the Camborne district.

The infection may thus be easily introduced into this ountry from the tropics and Southern Europe by returned ıiners, or even by those who have not followed any under-round employment abroad (soldiers, navvies, etc.); and from ermany, Belgium, France, and the Cornish mines by under-round workers. Cases have been recorded in Lanarkshire and n Belfast in the persons of soldiers, and in the former case a ıan was actually working as a miner when his illness attracted ttention. A large number of Poles are employed in the anarkshire coal-field, some of whom may have worked in estphalia or Hungary, and Italians have lately been intro-ıced into a metalliferous mine in the North of England.

(B) *Conditions found Underground in British Coal-mines, ch would influence the Establishment of the Worm.*—The con-ons of temperature on the surface are such that practically worm cannot spread among the ordinary population in this try. In summer, the eggs may hatch and the larvæ develop e infective stage in the open air, but any small danger might arise from this source is rendered negligible by ıost universal use amongst all classes in this country of ements for the proper disposal of excreta.

underground workings, however, the temperature, etc., ıently such that the eggs will quickly hatch and the evelop; there are very seldom any "sanitary arrange-and the darkness renders it difficult to avoid coming act with fæcal material.

emperature.—There is need of much more collected on respecting the actual temperatures found in coal-t would, however, appear that a temperature of 70°

Fahr. or more is found in parts of most pits, while temperatures of 80° Fahr. are not uncommon. The eggs may hatch and the larvæ reach the encapsuled stage, at any temperature from 60° Fahr. to about 95° to 100° Fahr.; the optimum [or most favourable] temperature seems to be about 75° to 80°. Below 60°, the eggs may occasionally hatch, but the larvæ will not grow to the infective stage. Once the larvæ have reached the infective stage, they seem to be largely indifferent as to temperature: they certainly live longer at room-temperature than at 98°, but not longer than at about 70° Fahr.

(2) *Moisture.*—Some water is to be found about all mines; even if there is very little standing water in the roads there is enough to produce a muddy condition at places. The worm cannot be propagated in complete absence of moisture, and the larvæ are soon killed by drying; but parts, at any rate, of most mines are sufficiently wet to allow the larvæ to grow freely. On the other hand, there may be too much water to allow the eggs to hatch. Eggs contained in fæces, covered with a shallow layer of water, will not produce larvæ at any temperature. Once hatched, however, the larvæ flourish in water.

(3) *Filth.*—Coal-mines appear to be a good deal cleaner, from a sanitary point of view, than metalliferous mines. This is in part due to the fact that at the face fæces are generally deposited in the goaf* and covered with coal-dust; and in part to the greater prevalence of dust and to the larger area. There is, however, no failure of sufficient fæcal contamination. In many instances, small partly-disused roads are made use of by the men for the purpose of relieving their bowels. This usage is particularly dangerous.

Duration of the Infection in Man.—Well-authenticated cases of infection, lasting more than six years after the last possible contact with infected materials, have been recorded.

Viability of the Worm in Mines.—Encapsuled larvæ have lived in the Gordon Laboratory for twelve months (still alive) at 68° Fahr. There is no direct evidence as to how long they may live underground, but in water obtained from two North Staffordshire mines they suffered no ill effect, and were observed for several weeks.

* The "goaf" or "gob" is the worked part of a mine, where the coal has been removed. The supporting timbers are withdrawn, and the roof is allowed to close on to the floor.

Natural Conditions in Mines which are Unfavourable to the Worm.—Parts of all, and nearly the whole of some mines, fail to produce the combination of dampness and warmth favourable to the hatching of eggs. But if the eggs cannot hatch in certain parts which are too cool, the larvæ can be brought to these parts either on the boots, etc., or by the flow of water. There is no evidence to show that any substance in the coal is deleterious to the worm, though weathered coal might contain such products. If the water is salt (as it is at the Levant mine) protection seems to be secured; but traces of the heavy metals (iron and copper) do not seem to be harmful.

Nothing is known of any natural enemies. In some mines, the fæcal deposits, wood, etc., show an abundant fauna, most commonly dipterous larvæ and small nematodes other than *Ankylostoma*.

It might be supposed that in the case of a species in which a single female produces millions (probably many millions) of eggs, some specific enemy would have been developed—some organism whose special characters enabled it to live on the highly nutritious contents of the eggs, or on the newly hatched larvæ. But if such a hostile species has been evolved it is in the tropical and sub-tropical home of *Ankylostoma* that it should be sought for, not in the temperate zone. In the mud of a British coal-mine, the limited number of species of animals and plants are either from the surface above, or have been brought with the timber from uninfected countries. It is possible, therefore, that in a warm and moist coal-mine in Great Britain the conditions are actually more favourable to the uncontested life of the larvæ than even in the tropics. It would not be out of harmony with any known facts to suppose that a single pair of worms might give rise in one generation to a progeny equal in number to the population of the British Islands.

(C) *Preventive Measures.*—(*a*) *In Non-infected Mines.*—1. A sufficient supply of sanitary pails, combined with a rigid system of inspection and cleaning, is all that is necessary if the use of these conveniences can be enforced. The habit of defæcating underground at all should be discouraged as much as possible: much may be done in this way by providing proper and well-looked-after accommodation at the pit's mouth. In dry mines

the fæces can probably be safely disposed of by burying them under coal-dust in the goaf; but in all cases permanent roads and stations should be provided with conveniences.

2. Examination of fresh hands. All men applying for work who have ever worked in tropical or South European countries, or in mines where the worm is known to be present, should be rejected until it is shown that they do not harbour the worm. It is useless doing this unless their state of health is entirely disregarded; it is of no moment whether they are, or have been, ill or not, since perfectly healthy persons may carry the worm and be capable of infecting a mine. Some sort of quarantine-list should be made. At present, it would include Cornwall, Westphalia, the French and Belgian coal-fields, Southern Europe, and all tropical countries.

3. Reduction of temperature and moisture is difficult, in most cases quite impracticable, and not necessary if proper sanitary and quarantine regulations are made and carried out. Any reduction in the moisture is, moreover, not unattended with danger from explosions.

There should be no difficulty in introducing a proper system of sanitary accommodation, if the genuine sympathy of both the mine-owners and the men's representatives could be secured. The additional expense in providing and looking after the pails, etc., would be relatively small, and in the larger pits should be practically inappreciable. In an English colliery, employing 2,000 underground hands, the excreta from the men on the working-roads have for the last four years been disposed of by the use of 100 movable pans, emptied on the spoil-heap once a week and recharged for use with coal-dust and a disinfectant fluid. The total cost is found to come to about £1 a week, and it is stated that the fouling of the roads has now ceased.

The number of hands which it would be necessary to examine individually would never be large. There is no need to examine men who live in England and are fresh to mining, or who have worked in a mine which is known to be free from the worm. In most English coal-fields, these would include the great majority of the men. The method of examination by means of blood-films affords a fairly satisfactory method, to which the men have no objection. It seems probable that many medical officers of mines are not competent to undertake the necessary investi-

gations; there would, however, be no difficulty in making arrangements with pathological and public-health laboratories such as have been established in many parts of England. It is only in accordance with the general policy of the country as to public health that the expenses of such examinations should be provided, in part at least, out of public funds.

(*b*) *In Infected Mines.*—The conditions here are altogether different, and may require the most drastic and expensive measures of universal examination and treatment, combined with anything that may be practicable in the way of cooling, drying, and disinfecting the mine. The great efforts made on the Continent thoroughly to disinfect infected mines, and their partial success, have been referred to in our opening paragraphs. Particulars will be found in blue books and other recent publications dealing with the subject.*

There is no evidence as yet of any natural process which would cause *Ankylostoma* to disappear from a mine in which it had once found a home. Total desertion of the mine by human beings would presumably have this effect, but it would appear necessary that such desertion should last not less than a year. And from the experience of the Westphalian and other European coal-fields it would appear probable that, if *Ankylostoma* should ever thoroughly take possession of one of the many warm and moist British coal-mines, it will not be eliminated, except by the invention of even more efficient disinfection than the drastic and expensive processes enjoined on the coal-masters by the German Government.

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* (1) *Ankylostomiasis: Reports on the Outbreak in the Westphalian Colliery District in Germany* [Parliamentary Paper, Cd. 1671], 1903.

(2) *Report on Ankylostomiasis in Westphalian Collieries*, by Dr. J. S. Haldane [Parliamentary Paper, Cd. 1843], 1903.

(3) "Ankylostomiasis," *The Colliery Guardian*, 1903, vol. lxxxvi., pages 975, 1026, 1078, 1135, 1184, 1235, 1287 and 1329.

(4) "An Outbreak of Ankylostomiasis in England. No. I.," by Drs. A. E. Boycott and J. S. Haldane, *The Journal of Hygiene*, 1903, vol. iii., page 95.

(5) "Ankylostomiasis. No. II.," by Drs. A. E. Boycott and J. S. Haldane, *The Journal of Hygiene*, 1904, vol. iv., page 73.

(6) "Further Observations on the Diagnosis of Ankylostoma Infection, with Special Reference to the Examination of the Blood," by Dr. A. E. Boycott, *The Journal of Hygiene*, 1904, vol. iv., page 437.

so diverse, even from one and the same locality, that the authors prefer to disregard them altogether. The after-shock which took place on April 4th, started from some point along the great fault-line that strikes from Oberburg westward across the Cerna Dolina, and thence across the Ulrichsberg towards Zirklach. Parallel with this, and a little to the south of it, trends the Egg-Glogowitz-Trifail fault-line, which apparently passes through the focus of the principal shock of March 31st. Therefore, the hypothesis that the cause of the earthquake here described lies in tectonic movements connected with the fault-system of the region, will not seem very far-fetched. The region, indeed, is a typically disturbed one, full of complicated folds, faults and overthrusts. L. L. B.

ELECTRICAL INSTALLATION AT THE GRAND HORNU COLLIERY, BELGIUM.

Installations électriques du Charbonnage du Grand Hornu, à Hornu. By A. MARCETTE. *Annales des Mines de Belgique*, 1904, *vol. ix., pages* 301-310.

It was decided to suppress the existing electrical station, and to replace all the engines and boilers of the colliery by a central electrical station producing three-phase current at 1,250 volts. This decision applied to 30 steam-engines aggregating 2,200 horsepower, and 27 boilers working at a pressure of 60 pounds per square inch, with 5,428 square feet of heating surface. The new installation comprizes a battery of high-pressure boilers and Sulzer engines coupled directly to the inductors of the alternators. Electric motors will do all the work of the mine: winding-engines, fans, underground haulage and pumping, surface-railways and aerial haulage, screening, saw-mill, and eventually air-compressors for working coal-cutting machines. In order to utilize the continuous-current motors already established, a transformer will be fixed in the central station.

The central station comprizes a large building, 98 feet long, 55 feet wide and 39 feet high, with a glazed roof, containing 6 semi-tubular Meunier boilers with 2,052 square feet of heating surface, working at a pressure of 150 pounds per square inch, fitted with automatic stokers, and Hering superheaters raising the temperature of the steam to 572° Fahr. The automatic stokers are worked by a three-phase motor of 14 horsepower, a feed-pump is worked by a similar motor, and a steam-pump completes the boiler-installation.

A second building, 85 feet long and 69 feet wide, with an annexe, contains the steam-engines and dynamos. The double-expansion horizontal tandem-engine on the Sulzer-Carels system, with variable cut-off, has the following dimensions:—Diameter of high-pressure cylinder, 31·5 inches; diameter of low-pressure cylinder, 51·2 inches; length of stroke, 53·1 inches. The engine runs at 88 revolutions per minute, and normally develops 1,340 horsepower, capable of rising to 2,100 horsepower, with an initial pressure of 135 pounds per square inch.

Two of these engines are coupled to the revolving inductor of the principal alternator. This inductor, 24·6 feet in diameter, weighs 92 tons, and is capable of developing 4,000 kilowatts at 1,250 volts. The third engine works the reserve alternator, with a revolving inductor, 16·4 feet in diameter, weighing 72·5 tons, and developing 2,000 kilowatts.

When all the services are connected with the central station, the first alternator will work them. In case of accident to one of the engines, it

will be possible to remove the connecting-rod and work the two alternators in parallel. In case of actual necessity, the reserve alternator could, for a time, carry on the work by arrangement of the calls for power.

Each tandem-engine is provided with an injection-condenser, and the water, after being cleansed of oil and cooled, returns to the condensers. The maker has guaranteed a consumption of steam of 12·10 pounds per horse-power for the normal power with 16 per cent. of admission, and 14·30 pounds for the maximum power.

A rotary transformer, comprizing a three-phase motor of 350 horsepower, running at 430 revolutions per minute, is placed between the two alternators and works, directly, a continuous-current dynamo of 80 kilowatts at 230 volts, for lighting and excitation of the alternators, and also a continuous-current dynamo of 135 kilowatts at 600 volts for the supply of the motors already established aboveground and belowground, hitherto worked by the existing installation.

In the basement, a Pollack battery of 130 elements, of a capacity of 135 ampère-hours, serves as a stand-by for the lighting and to supply the exciting current for starting the alternators.

The central station contains a switchboard, 49 feet long, occupying one of the long sides of the building parallel to the rotary transformer. It is divided into three stages. The upper stage, where all the appliances are worked, comprizes three panels of white marble on which are fixed all the continuous-current and low-tension three-phase instruments. The middle stage, in the basement, accessible only by a special staircase, contains the high-tension appliances. Below these are the cable-attachments. The current of each alternator passes first by an oil-switch, and then feeds three omnibus-bars at 1,250 volts, from which all the circuits are supplied. Each circuit has a three-pole automatic switch capable of being worked from the upper stage. The magnets of these appliances are fed by a continuous current at 220 volts.

Ten circuits are provided for on the omnibus-bars at 1,250 volts, seven of which are already installed, as follows:—(1) Rotary transformer-motor. (2) Winding-engine at No. 7 pit, distant 165 feet. (3) Winding-engine at No. 12 pit, distant 1,560 feet. (4) Capell fan at No. 8 pit, distant 585 feet. (5) Fan at No. 2 pit, distant 390 feet. (6) Underground pumps at the 2,310 feet level of No. 7 pit at a distance of 2,610 feet. (7) Screening, endless chain and aerial haulage.

Winding-engines.—The electric winding-engine at No. 7 pit is nearly ready for work, and at some future time the steam-engine at No. 9 pit will be replaced. The winding-engine is of the Preussen-colliery type. On the shaft of the engine, which has three bearings, is fixed the rotor of a motor with a revolving field, and the two drums for flat aloe-ropes and the brake-pulley. A depth of 3,900 feet is provided for (although the shaft is only yet sunk 2,196 feet) with a useful load of 5,720 pounds and an average speed of 31·16 feet per second. The speed for winding men will be limited to a maximum of 18 feet per second, but for winding coal the speed may attain 56 feet, and it may be reduced to 0·36 foot for examining the shaft. The electric motor is of 460 horsepower, at 42 revolutions per minute, with a maximum of 1,000 horsepower. The rotor is provided with rings for starting and regulating the speed. The current, brought from the central station by a subterranean cable with three conductors of 0·48 square inch, passes first by a three-pole switch of 600 ampères, then by a safety cut-out, by the reverser, and so to the stator of the motor. The rings of the rotor are directly

united to the plates of the circulating liquid starting resistance. A static transformer lowers the tension from 1,200 to 220 volts, for feeding the motor of the pump of the starting resistance and the electro-magnets of the electro-magnetic brake. This is composed, as usual, of two blocks of wood embracing the pulley. The No. 7 pit, being only 100 feet from the boilers, the brake would normally be actuated at this pit by steam; but in addition it could be applied sharply, in case of urgency, by a counter-weight operated by a pedal or even automatically. The breaking of the current would be caused, moreover, in all cases by the automatic opening of the safety-switch at the time of the pressure of the brake, caused either by the engineman or automatically by the overwinding apparatus, or by failure of the current from the central station. Moreover, a retarding appliance, independent of the engineman, may be arranged, so that the cage arrives at bank at as slow a speed as may be wished, which renders the operation of the detaching-hook very certain. This appliance opens the sluice of the rheostat when the cage is not more than 164 feet from bank, by automatically moving the engineman's lever. The same appliance allows, in addition, of the regulation, by the simple preliminary movement of a lever, of the speed of the cages so as not to surpass a fixed maximum for winding men or minerals, in case of inattention on the part of the engineman.

Fans.—The Capell fan at No. 8 pit will be worked through belting or ropes by a three-phase motor of 200 horsepower, at 270 revolutions per minute. For greater security there will be two cables from the central station to the motor; like all the feeders, they will be armoured and carried underground. The switchboard consists of two three-pole cut-outs, an oil-switch, a voltmeter and an ampèremeter. The rotor is furnished with starting rings and a short-circuit appliance. The metallic starting resistance admits of a permanent reduction of 50 per cent. in the speed during the examination of the shaft, to prevent the too great speed of the air.

Pumping.—Beyond the continuous-current pump working at the 2,559 feet level, which will be fed by the rotary transformer, a Riedler express pump has been fixed at the 2,322 feet level and will be worked by three-phase current from the omnibus bars of the switchboard. The three-phase motor of 125 horsepower at 165 revolutions per minute is coupled directly to the pump, which is capable of raising 1,412 cubic feet of water per hour to a height of 2,328 feet.

Screening, Endless Chain and Aerial Ropeway.—The plant actuated by three-phase current from the central station is as follows:—(1) The motor of the endless chain brings the tubs of coal and stone from No. 7 pit to the screening-plant. Narrow-gauge electric locomotives (continuous current on the trolley-system) bring the output of Nos. 9 and 12 pits. (2) The aerial ropeway carries screened coal and stones to the wharf and sidings of the colliery at St. Ghislain, a distance of 5,886 feet. (3) The Allard screening-plant is actuated by two motors of 45 horsepower, and deals with 1,500 tons per day.

Transmission of Power by Continuous Current.—The central station supplies continuous current to the following plant:—(1) The narrow-gauge trolley-locomotive connecting the Nos. 7, 9 and 12 pits, and endless chain to the screens. (2) The low-tension lighting. (3) The high-tension lighting. (4) The electric pump at the 2,559 feet level of No. 12 pit. (5) Four or five winches, some direct coupled and some by gearing, in different parts of the workings for dip haulage or staples. W. N. A.

the central electric station of the Verein Gladbeck I. and II. colliery, district of West Recklinghausen, was found with his neck broken just outside the switch-room. He had been, apparently, meddling with a transformer which he had no business to touch, and had been partly stunned by a shock from a high-tension current: he must have dragged himself out of the room and then fallen, in such a way as to break his neck, against the window-sill. There was no defect in the electric installation, which had been laid down in such a manner as to comply fully with all the provisos enforced by the Association of German Electricians in 1900.

Another accident took place on October 1st, 1902, at the Mont Cenis I. colliery, third district of Dortmund. An ignorant attempt to remedy the defects of a voltmeter by linking it up wrongly with another voltmeter resulted in short-circuiting, and one man was slightly burnt. This accident, like that at the Hansa colliery, briefly described above, is held to prove that in selecting workmen for electric installations, sufficient care is not always taken to instruct them fully beforehand as to the dangers against which they must guard. L. L. B.

ANKYLOSTOMIASIS IN DORTMUND.

Zum Stande der Wurmkrankheit. ANON. *Glückauf*, 1903, *vol. xxxix., page* 1138.

The microscopical examination of the excreta of not less than 20 per cent. of the men employed underground, which was ordered by the Royal Department of Mines on July 21st, 1903, has been practically completed, and the results are now to hand. When these figures are compared with the statistics of the number of men employed underground in the second quarter of this year, a fair idea is obtained of the spread of the worm-disease, and the number of worm-sick persons in the province of Dortmund.

TABLE I.—WORM-SICK WORKMEN IN 1903.

Name of Mines-inspection District.	Average number of Workmen employed Underground.	Number of Worm-sick Persons, including those Worm-affected. No.	Percentage of Number employed Underground.
Hamm	812	30	3·7
Dortmund I.	12,398	195	1·6
Dortmund II.	13,976	435	3·1
Dortmund III.	13,874	3,882	28·0
East Recklinghausen ...	11,223	1,126	10·0
West Recklinghausen ...	11,780	275	2·3
Witten	9,240	372	4·0
Hattingen	8,207	512	6·2
South Bochum	9,411	874	9·3
North Bochum	10,711	2,359	22·0
Herne	12,785	2,373	18·6
Gelsenkirchen	10,603	516	4·9
Wattenscheid	12,987	1,301	10·0
East Essen ...	10,917	157	1·4
West Essen	11,098	256	2·3
South Essen	8,378	1,197	14·3
Werden	1,316	210	16·0
Oberhausen	19,014	1,091	5·7
Totals	188,730	17,161	9·1

population." From the unfortunate conditions in which they live the sulphur-miners transmit from generation to generation the sad heritage of a laborious existence: burdened from the close of their earliest years with labour to which in age and constitution they are unequal, their body develops with difficulty, being consumed from the moment of forming. Scarcity of food and the bad hygienic conditions concur to bring about this degeneration, but premature and excessive labour represent the chief cause.

Before 1886, children began to work at 7 years of age; then the law allowed work to begin at 10 years, or for transporting minerals from below-ground to the surface, at 12 years of age; but this last regulation was not very efficaceous, since it was always easy to the labourers to prove, by means of friendly certificates, that all the carusi of 10 years of age present at the time of an inspection were engaged in transport in "short galleries and of light weight" such as the law allows.

Shoulder-work has been carried on, therefore, at the age which physiology desires should be most respected, that is, in the period when all that is movement and which contributes to exercise an organ as a function should have free play, when the principal object should be to favour the normal growth of the body and to strengthen the powers of vital resistance.

The writer states that he will not repeat the descriptions of the truth which Doctors Villari, Mario, Giordano, Rossi, Chiesi, and many others have published, respecting the work of the Sicilian carusi. But he believes that one who has not seen for himself cannot thoroughly realize what a pitiful spectacle it is. He had felt heart-tightenings which will remain indelible for the whole of his life, and he seemed to hear still the plaintive groan of the carusi as they issue from the mouth of the sulphur-mine, dripping with perspiration and trembling on unfirm legs from the excessive burden of mineral. The weight carried varies from 30 to 40 kilogrammes, according to the age and strength of the caruso; but it must be noted that the hewer (*picconiere*) has an experienced eye for size of chest and waist, and apportions the weight according to the energy of the boy: what is certain is, that on weighing the burden of any caruso, it is always found to be notably greater than that indicated by the hewer. Hence it can be affirmed without exaggeration that ordinarily the load is up to the extreme limit which the caruso can bear, and in this the matter of fines is also partly to blame.

The evil of the excessive weights is aggravated by the bad roads, by reason of which in time the vertebral column of the caruso becomes bent and twisted, the shoulders become unequal, the chest becomes hollow, the abdomen becomes pinched in and salient, the clavicular fossæ become deeper, the muscles lose their symmetry and are in certain parts hypertrophied: and whilst the upper limbs are elongated, the neck remains short and heavy, the head becomes bald and bends downwards, the lumbar regions are *quasi* disjointed, the feet broad and flat, and the knees thicken in contrast with the legs which remain agile and thin. The individual altogether presents, as marks of fatiguing and abnormal labour, all the characters of premature senility.

Again, during shoulder-carriage, the thoracic chamber, owing to the tension of the muscles and of the diaphragm, keeps in the position of forced inspiration; in consequence, the thoracic circulation remains in the incipient stage and the heart, as in the case of excessive work, exaggerating the physiological tendency, increases in volume more rapidly than in contractile energy. Thus, whilst the ground is prepared for cardiac vices and for

pulmonary emphysema, the blood supercharges itself more easily with carbonic acid and with the degenerative principles constituted by the dead products of muscular activity. In other ways, owing to the susceptibility proper to youth, and the great sensitiveness of their nervous apparatus, the various noxious influences of underground labour weigh most heavily on the carusi.

There are here, therefore, all the conditions conducive to national decadence. The official statistics of the rejected military conscripts do not offer evidence bearing upon the consequences of the labour of the carusi: the percentage of these rejected youths in the sulphur-regions is not among the highest. Other localities present higher percentages where there are no mines, and that because other factors enter into play; but Dr. Colajanni, comparing the percentage of the rejected of the levies for 1872 and 1873 in the district of Piazza Armerina, belonging to the classes of peasants and miners, found as regards the first, a mean for the two years of 21·35 per cent., and as regards the second 42·49 per cent. Dr. Giordano, for the 1856-1875 levies in the commune of Lercara, found a mean percentage of 26·06 for the agricultural labourers, and 39·50 for the miners. Dr. Giardina, for the quinquennium 1876-1880, in the province of Caltanissetta, found a mean of 25·48 per cent. for the peasants, and 43·89 per cent. for the miners.

The law of February 11th, 1886, has not produced any sensible benefit. Such benefit, however limited, as might have been expected, is lost, because it is not possible to conquer the passive resistance of all the workers and of not a few of the masters, to the application of the more important hygienic requirements recommended by that law. The reports by the Minister of Agriculture, which precede the various projects of legislation presented since 1893, bear witness to this.

The prohibition of shoulder-labour would be a radical measure, which may seem possible to some, but would result in incommensurable evils to the industry in question, and therefore also to the workers themselves. But it is all the more needful that one should contrive a means of restricting so primitive and so pernicious a form of work. And, fortunately, statistics show that the percentage of mineral brought to bank by mechanical means is gradually increasing. At the same time, the percentage of boys under 12 working in the sulphur-mines is diminishing.

The 1886 law has nevertheless helped to guide the sulphur-industry toward more rigorous hygienic supervision; and the new law, which limits the admission of underground workers to those over 13 and, after three years to come, over 14 years of age, if mechanical traction did not exist, would still mark in Sicily a step forward not too violent.

With it there would still not be full agreement with the physiological laws of bodily development, but as Mr. San Giuliano demonstrated in his report to the Chamber of Deputies, a more rigorous law might be borne by the peasants, though it certainly would not be borne by the carusi and their families.

It appears to Dr. Giardina that the hygiene department of the sulphur-mines may declare itself satisfied with the new measure of social legislation following the Baccelli law, and should limit itself to hoping that means may be found to enforce properly the application of the new regulations.

With this view, the Chamber have invited the Government to present as soon as possible the proposals necessary for the augmentation of officials charged with carrying out the law in question. At present the *personnel*

s absolutely insufficient. And, adds Dr. Giardina, any legal regulations will be useless unless the teaching of hygiene is instituted. This, if funds are not otherwise available, might be attached to the duties of the provincial medical men and of the communal sanitary officials.

The sanitary officials of Sicily have expressed to Dr. Giardina their conviction that middle life is shorter and infirmities come earlier with the sulphur-miners than with other labourers, especially agriculturists; so that, usually, there are few such miners in active work at 55. A comparison has been instituted of the data derived from 485 sulphur-miners dead and 468 incapacitated during the years 1894-1898, in the mining centres of Caltanisetta, Piazza Armerina, Centuripe, Casteltermini, Riesi, Grotte, Favara, etc., with the conditions obtaining among the coal-miners of Germany—data which cannot lead to generalizations, owing to the restricted evidence on which the conclusions for Sicily are based, but nevertheless demonstrate that, whilst of 1,000 German miners, on an average 19·99 only were invalided and 9·60 died; of the same number of sulphur-miners in Sicily 23·17 became incapacitated and 12·17 died; and the mean age of invaliding, which for the Germans (1885-95) was 48·7, was for the *solfatari* 42·39.

Passing over accidents in working (to which the author also refers) a few points may be summarily mentioned as to the various maladies. The sanitary officials are agreed that both acute and chronic affections of the respiratory apparatus are extremely common among the sulphur-miners: it could not be otherwise, in surroundings in which all the conditions favourable to such diseases are united. The respiratory forces are strongly called upon by the long and broken-down ladders, and the hard labour in badly ventilated galleries prepares the ground; and sudden and frequent chills and the powder-dust of sulphur, together with irritant gases, determine the development of such diseases. In fact, in the sulphur-mines the entire series of affections of the respiratory apparatus is met with, both acute and chronic (angina, laryngitis, bronchitis, pneumonia, pleurisy, emphysema, pneumoconiosis . . . . .), complicated, or followed by, cardiac maladies. And the chronic lesions follow upon the acute lesions as a final phase of these, or assume from the beginning a slow course due to the constant repetition of the same morbific influences. The strenuousness of the labour, the great diffusion of chronic affections of the respiratory organs and rheumatism, are so many etiologic causes of cardiac disease which, as a matter of fact, is frequently observed among the sulphur-workers. Gastro-intestinal diseases are common among them too.

The gravest cause of sickness amongst the sulphur-miners is malaria, according to information furnished by the sanitary officials; it exists, but Dr. Giardina has been able to convince himself that in most cases anæmia, due to *Ankylostoma*, is mistaken for it, a disease that truly produces the gravest illness and therefore merits special attention. G. A. L.

ANKYLOSTOMA IN THE SULPHUR-MINES OF SICILY.

L'Igiene nelle Solfare di Sicilia: L'Anchilostomiasi. *By* Dr. G. Giardina. *Rassegna Mineraria*, 1903, *vol. xix.*, *pages* 115-117; *also Glückauf*, 1903, *vol. xxxix.*, *pages* 1240-1243.

The climate of Italy is eminently favourable to the free development of *Ankylostoma*, both aboveground and belowground. On the surface, those

engaged in agricultural labour (especially rice-cultivators) and in the tile- or brick-making are the most exposed to ankylostomiasis, though isolated cases of the disease are not unknown amongst those following other occupations; but probably miners are, beyond all others, exposed to infection. The conditions in which their work is carried on are extremely suitable to the existence of the parasite, and at the same time weaken the power of resistance of the workers exposed to its attack.

Ankylostomiasis occurs in the mines of Venetia, the Romagna, Sardinia and Sicily. Other mining districts cannot be said to be free from it, but records of its occurrence in them are wanting.

It was first noticed in Sicily in 1882, when Dr. Giuffrè found numerous eggs of *Ankylostoma* in the fæces of an anæmic sulphur-worker from Lercara. Since then the cases recognized in the island have become more and more numerous. In 1898, visiting Lercara, Dr. Giardina paid special attention to ankylostomiasis. In that year, it seems, there commenced an increase in the number of cases, owing to the reflux from the burning zones of the mines which rendered the conditions more favourable to the free life of the organism. A commission (consisting of Doctors Giardina, Giordano and, later, Previtera, together with an engineer, Mr. Gabet) was then appointed to enquire into the hygienic conditions of the sulphur-workings. The investigations of this commission comprised the examination of about 20,000 workers, and resulted in the estimate that on the average 30 per cent. of the *solfatari* suffered from ankylostomiasis.

The disease has not yet shown itself in all the mining centres, but has invaded most of them, including the most outlying ones (Cianciana and Caltagirone). The chief foci of infection are ascertained to be about the sulphur-mines of Muglia (province of Catania), Lercara (province of Palermo), Lucia Ficuzza and Comitini-Aragona (province of Girgenti). Strongly infected also are the mines of Trabia, Tallarita, Gallitano, Stretto Giordano, Gibisa, San Michele and Ciavolotta Monteleone. The nomadic life of the workman, changing from mine to mine, aggravates the peril of a greater extension of the disease.

It is impossible to overstate the desolation of a mining centre attacked by ankylostomous anæmia. In such a spot the eye is met by a multitude of pale-faced, tired, apathetic men, with dulled eyes, dragging themselves to their work in terror of the evil which has killed so many of their mates.

After an explanation of the peculiar life-history of *Ankylostoma* and the conditions necessary for their full development, the means proposed to combat the spread of the disease are described. It is pointed out that not only is the free life of the parasite to be aimed at, but especially its second phase; that which accomplishes itself within the intestines of the sufferers. Each individual cured represents one focus of infection the less. In the actual conditions of the Sicilian mines isolation of the affected miners is not possible. Dispensaries must first be established, and a special service of hygienic vigilance; but, above all, some means must be devised to render forced abstention from work tolerable to the patients. In the meantime, all that can be done is to use all available means to prevent the dispersal of infected matter and the multiplication of larvæ, and to reduce, as far as possible, the occasions of contact inevitable in working the mines. In doing this, the unclean habits and ignorance of the men are one of the greatest difficulties to be met. Before all, the problem of the collection and removal to a distance of the fæcal matter is to be solved, and that without infecting

the ground. A solution of general application has not yet been arrived at. Movable vessels have been condemned by some competent authorities. One of the most necessary prophylactics is the dessication of the ground. Dr. Previtera has specially considered the question of soil-and-water disinfection. This, he says, can be accomplished safely and quickly by strong solutions of sodium chloride or vapours of sulphurous anhydride (sulphur dioxide). The same effect, but slower (two or three days), can be got by using a dilute solution of sodium chloride (10 per cent.), ferrous sulphate (20 per cent.) and larvicide (1 per cent.). Once disinfected, the ground should be kept impregnated with a weaker solution of the latter kind (3 to 5 per cent. of sodium chloride, 2 per cent. of ferrous sulphate and 1 per 1,000 of larvicide). Beyond these recommendations, nothing is suggested but attention to the ordinary laws of sanitation and hygiene. Of what the "larvicide" mentioned consists is not stated. G. A. L.

MINERS' PHTHISIS IN THE TRANSVAAL.

Miners' Phthisis Competition Committee: Report of the Judges. Transvaal Chamber of Mines, April, 1904.

In October, 1902, advertisements were inserted in the principal papers of the world by the Transvaal Chamber of Mines, offering prizes of £500 (and medal), £250 and £100, for the "three best practical suggestions and devices" for obviating, minimizing or combating the causes leading to what is known as "miners' phthisis." The advertisement stated that while no definite information was before the Chamber, it was generally assumed that the cause of the disease lay in the inhalation by the men of the fine dust produced by the rock-drills.

In all, 229 competitors entered. At an early stage, the judges condemned as "impracticable and useless" all kinds of respirators, masks, hoods and dust-extractors, to the number of 76; and also 52 medical and miscellaneous suggestions such as "lung-tonic," "diet," "ventilation," "keeping a pebble in the mouth," etc. There were 60 suggestions for delivering jets of water at the mouth of the hole, one of which was tried by the judges; they were, however, condemned as being liable to cause the drill to stick. Jets inside the hole, and also sprays, were found to be open to the same objections, and were discarded.

It was decided to institute exhaustive tests as regards water-drills, and makers in Great Britain were invited to send out complete drills, the freight out and back to be paid by the Chamber of Mines. Specifications of nine drills had been received, but only two, the Leyner and the Ingersoll-Sergeant, were able to enter the practical competition. In the ten weeks' test run, neither did very good work, but as the principle of the water-drill was approved by the judges, the Leyner was awarded the second prize of £250 *pour encourager les autres*.

Of the six atomizers competing, that of Mr. Thomas J. Britten was found to be most useful, and perfect mechanically; 75 per cent. of the dust is laid, nitrous fumes from explosives removed and ventilation assisted. Carbonic acid can also be removed if lime-water be used. The dust from blasting and shovelling is laid as well as that from drilling. On the other hand, it requires extra attention, separate mechanism, a perfectly pure water-supply to the mine, and necessitates the men working in an atmosphere supersaturated with moisture; also, as it is unconnected with the drill, the

men may prefer to leave it alone rather than meddle with it. The award of £500 and the gold medal were given to Mr. Britten's atomizer, as being the best practical device suggested. The third prize was not awarded.

Attached to the report are various subsidiary reports on atomizers and water-drills, an account of which follows:—

(1) A report of Dr. Walter C. C. Pakes, Government Analyst and Bacteriologist to the Transvaal, on the amount of dust and humidity produced under working conditions. His experiments show that, as regards humidity, a spray is preferable to the Britten atomizer, since it does not saturate the air with moisture, and that both have about the same settling-power for dust, namely, about 75 per cent.

(2) A memorandum by Doctors Louis G. Irvine, Donald Macaulay and Walter C. C. Pakes on the chemical and medical aspects of atomizers in mining operations. This report states that the effect of the atomizer is to remove from the area of the mine 75 per cent. of the dust, the whole of the nitrous fumes produced by the dynamite, and a very small proportion of the carbonic acid. The amount of carbonic oxide is unaffected. While the direct breathing of the atmosphere supersaturated with moisture has little deleterious effect, attention is drawn to the well-known dangers connected with passing from a warm, moist atmosphere to a cold, dry one; since, however, the ordinary relative humidity of the mine is about 90 per cent., which is increased to 100 per cent. by the atomizer, this effect is not considered important.

(3) Reports by Mr. W. H. Wood on tests of water-feed air-drills, carried out by the Crown Reef Gold-mining Company, Limited. This test lasted ten weeks, the Ingersoll-Sergeant water-fed drill and the Leyner Drill Company's model 5 drill competing (Table I.). After six weeks, the drills were put on double shifts, and run by Italian drill-men in place of experts (Table II.). A full account is given of the delays with each drill and the causes; these latter were various: in the case of the Leyner they were chiefly pawls and pawl-springs. Table III. summarizes lost time and records the comparative costs of repairs.

Mr. Wood draws attention to the superiority of the Leyner rock-drill, as evidenced by the above figures, and adds that, at the end of the trial, while the Leyner drill showed "considerable signs of wear-and-tear" the Ingersoll drill was practically worn out. In conclusion, he thinks that "the Leyner principle is the better of the two on which to work, but that it contains structural defects which should be overcome."

TABLE I.—SUMMARY OF WORK DONE BY EXPERT ROCK-DRILL MEN.

	Ingersoll.	Leyner.
No. of bits used	400	951
No. of shifts worked	28	38
No. of holes drilled	194	116
Average depth of hole drilled per minute	1·81 inches	1·81 inches
Total depth of holes	635 feet	1,011 feet
Actual time engaged in drilling ...	69 hrs. 54 min.	111 hrs. 20 min.
Time lost in repairing underground	21 hrs. 6 min.	3 hrs. 25 min.
Time lost in repairing on the surface	27 hrs. 30 min.	nil.
Average air-pressure per square inch	61 pounds	60·8 pounds

TABLE II.—SUMMARY OF WORK DONE BY ITALIAN ROCK-DRILL MEN.

	Ingersoll.	Leyner.
No. of bits used	112	541
No. of shifts worked	12	33
No. of holes drilled	25	91
Average depth of hole drilled per minute	0·3 inch	0·81 inch
Total depth of holes	111 feet	411 feet
Actual time engaged in drilling ...	30 hrs. 31 min.	106 hrs. 17 min.
Time lost in repairing underground	31 hrs. 23 min.	15 hrs. 53 min.
Time lost in repairing on the surface	130 hrs. 30 min.	6 hrs. 15 min.
Average air-pressure per square inch	67 pounds	68 pounds

TABLE III.—SUMMARY OF TESTS BY EXPERT AND ITALIAN ROCK-DRILL MEN.

	Ingersoll.	Leyner.
Time lost in repairs	210 hrs. 29 min.	25 hrs. 33 min.
Cost of repairs and spare parts ...	£9 19s. 7½d.	£9 0s. 6d.
No. of shifts worked	40	71
Cost of repairs per shift	4s. 11¾d.	2s. 6½d.

(4) A circular-letter was sent to several users of the Leyner drill asking for their experience. Mr. Joseph P. Gazzam, of the Simmer & Jack Proprietary Mines, Limited, who had had the drill in use for about a year, wrote favourably of it, especially for use in rises. Two users who had had the drills, for six weeks and three months respectively, speak unfavourably of it except for use in rises. Two users, from whom replies were received, had only had the drill in use for a few weeks. G. P. L.

EARTH-TREMORS PRODUCED BY MINING IN THE PŘIBRAM DISTRICT, BOHEMIA.

Über Erderschütterungen im Přibramer Bergbaugebiet. By FRANZ MLÁDEK. *Österreichische Zeitschrift für Berg- und Hüttenwesen*, 1905, *vol. liii., pages* 349-351 *and* 1 *plate.*

Earth-tremors, in former days quite unknown in the district, have been making themselves felt of late in the neighbourhood of the Birkenberg main shafts. They recur at irregular intervals, and have aroused a certain amount of disquietude.

The metalliferous ore-veins of Birkenberg traverse a basin of Cambrian greywackés: the strata dip 80 degrees eastward, and strike slightly north of west. The thickness of the individual beds varies considerably, and so too does that of the metalliferous veins (from nothing to 40 feet), but the pitch of the latter coincides with the dip of the country-rock. The veins, as a whole, form a complex of principal veins striking north and south, connected one with the other by accessory veins and clefts of predominantly north-westerly strike. They are generally associated with diabase-dykes, and many of the principal veins have been proved to a depth of 3,600 feet or more. So far as their upper half is concerned, the veins are almost completely worked out, and in the lower half rapid progress is being made in the same direction.

The author argues, illustrating his argument by means of diagrams, that these tremors will increase in proportion as the working-out of the veins advances. He shows that the effect of the mining operations is to isolate inclined pillars of rock, which, by pressure in one direction and extension in another, bring about deformation of the strata. The greater is the weight of the pillar, the greater of course does this effect become, and so we have here an apparently incommensurable difficulty in the path of those who wish to pursue mining operations (in this district) at great depths. Even the most careful packing appears to be unavailing to prevent motion of the inclined pillars of rock, and then the excavations incidental to ordinary working have disturbed the natural cohesion of the entire mass of country-rock. As a matter of fact, they have so split up the inclined pillars of rock as to enhance the above-mentioned effects of gravity, etc. The result is that either the foot-wall or the hanging-wall (roof or floor) rises, bursts and breaks down with a noise and a vibration resembling those produced by the blow of a heavy steam-hammer.

The author recites examples of the destruction wrought by these rock-movements in various mines in June and September, 1904, and in February, 1905. Sometimes the effect of these tremors is hardly noticed at the surface, the seismographic records being very various in this respect. However it may be, it is quite certain that these phenomena have nothing to do with earthquakes proper. Moreover, it is understandable now that not all the breakages, etc., observed in the Přibram mine-workings are fairly attributable to the effects of shattering explosives. If mining is pursued to greater depths, changes in method will be indispensable to meet the circumstances recited herein. L. L. B.

EARTHQUAKES IN BAVARIA.

(1) *Das Erdbeben am 5. und 6. März 1903 im Erz- und Fichtelgebirge mit Böhmerwalde, und das Erdbeben am 22. März 1903 in der Rheinpfalz; and*
(2) *Die Erdbeben Bayerns im Jahre 1903.* By DR. JOSEPH REINDL. *Geognostische Jahreshefte, 1903, vol. xvi., pages* 1-24 *and* 69-75, *with* 3 *figures in the text and* 2 *plates.*

The seismic year, 1903, opened on the evening of January 8th, and closed on the morning of December 17th, the total number of recorded earthquakes amounting to 27 in that interval of time. The seismic curve plotted out by the author of the second paper shows minima in February and June, with an extraordinarily sudden rise to a maximum in March and a gradual, all but uninterrupted rise to a less conspicuous maximum from the beginning of July far into December. It is noteworthy that the immensely greater number of the tremors were observed at night, or in the early morning or late evening. In the formerly volcanic district of the Ries the earth's crust has evidently not yet settled down into a condition of permanent equilibrium: movements due to overthrust, breakdown and tension respectively, are still going on, and the diversity of texture and character of the rocks is in this case by no means a negligible factor. Earthquake-sounds were almost universally noticed in connection with the shocks; but there are no reliable data, either as to the velocity of propagation of the shocks, or as to the depth at which the epicentra were situated. The intensity was hardly ever less than 4 in the De Rossi-Forel scale.

The first paper contains a detailed description of the earthquakes of

March 5th, 6th and 22nd, 1903. Fore-shocks had been going on for four weeks, more or less, before the first-mentioned date, no less than 20 being reported from the neighbourhood of Asch, and several from that of Graslitz and the bordering district of the Vogtland. The principal shocks of March 5th and 6th affected an area extending from Passau on the south to Leipzig on the north, and from Bamberg on the west to Prague on the east (25,477 square miles). The pleistoseismic area (173·7 square miles) lay mostly outside Bavarian territory, that is, part in Saxony and part in Bohemia. At Asch, the shocks in the night of March 5th to the 6th were so violent that chimneys crashed down, masses of rock came hurtling through the air from the Haslau crags, the electric lights in the town went out, and the terror-stricken inhabitants spent the night in the open. At Graslitz, a yawning fissure, 10 feet wide, was opened up in the earth. At Selb, one of the Bavarian frontier-villages, the walls of many of the houses showed broad-gaping cracks. The intensity of the principal shocks within the pleistoseismic area was from 6 to 7 of the De Rossi-Forel scale. A great number of records are tabulated from various Bavarian localities which lie within the next isoseismal curve on the map, wherein the intensity varied from 4 to 5 of the same scale. The zone of medium intensity, such as this, cannot, however, according to the author, be very definitely marked off from the zone of feebler intensity included within the outermost isoseismal. In this outermost zone the intensity averaged 3 in the De Rossi-Forel scale, which implies a shock that is perceptible to ordinary persons only under the most favourable circumstances of observation. After-shocks were felt at Graslitz and Asch on March 7th and 9th, 1903, respectively. The principal earthquake travelled from west to east, but its velocity of propagation and the depth of the epicentrum (which lay somewhere below Asch) are alike undeterminable. It is curious to note that the pitmen in the Falkenau collieries felt nothing, while those in the Zwickau mining district were so scared that they all left the workings and came to bank. The flow of springs in certain districts was disturbed, although those of Karlsbad remained unaffected, and disturbances too were noticed in the telegraph-cables between Munich and Berlin. The cause of the earthquake is to be sought in the tectonic phenomena that have characterized the region which is here dealt with since Tertiary times. It seems evident that a huge sagging operation is in process, transversely to the strike of the Erzgebirge, which will take some thousands of years to complete.

The Rhenish Palatinate, the eastern half of which has been repeatedly the scene of seismic disturbances during the past eleven hundred years, was once again shaken by a violent earthquake on the morning of March 22nd, 1903. The intensity within the pleistoseismic area attained 7 in the De Rossi-Forel scale, considerable damage being done to house-property, more especially in the neighbourhood of Kandel. In a great number of localities the intensity was equivalent to 6 in the above-mentioned scale, while the area included within the isoseismal 4 to 5 embraced 309 square miles, and, like the pleistoseismic area, has the form of an ellipse, the major axis of which strikes north-west and south-east. The area included within isoseismal 3 covers about 618 square miles. The reports as to the number, duration and direction of travel of the principal shocks are conflicting. However, it seems fairly certain that 4 seconds would represent correctly the duration of the most violent shock. After-shocks were felt on various dates up to April 9th, 1903. Here again the cause of the earthquake is revealed by a study of the

tectonic structure of the pleistoseismic area, which for the most part lies within the gigantic fault-depression known as the Rhenish fosse or *graben*. The elevation of the mountains of the Rhineland and the sagging or subsidence of the Upper Rhenish plain took place either simultaneously along a single fault-fissure, or gradually along a whole series of successive fissures. The process of dislocation began in Tertiary times, and with it volcanic phenomena were then associated, active vulcanicity in that region finally ceasing in the Pliocene period; but the tectonic disturbances have continued into our own day, and of these the earthquake here recorded is a visible sign. It proves the existence of a cross-fissure in the Haardt massif, transverse to the already-known great longitudinal fissures. Arising as it did in the Palatinate, this earthquake appears to have induced "sympathetic" earth-tremors in Italy, Southern France and Southern England, but its waves broke harmlessly against the crags of the Black Forest massif.

(3) *Ergänzungen und Nachträge zu v. Gümbels Erdbebenkatalog.* By Dr. Joseph Reindl. *Sitzungsberichte der mathematisch-physikalischen Klasse der K. B. Akademie der Wissenschaften zu München*, 1905, *pages* 31-68, *with a map in the text and one plate.*

The late Dr. W. von Gümbel published his catalogue, confessedly incomplete, of Bavarian earthquakes in the proceedings of the Munich Academy for 1889 and 1898 respectively. The present author, thanks to a more detailed investigation of the literature of the subject, has been enabled vastly to extend this catalogue, not only by the addition of fresh records, but by supplying full descriptions in many cases where the former author had merely noted the bare fact of the occurrence of an earthquake on a given date. Moreover, he brings down the catalogue to December, 1904, the records given by him thus ranging over more than eleven centuries (reckoning from the great Regensburg or Ratisbon earthquake of A.D. 786).

As in many other parts of Europe, the great Lisbon earthquake of November 1st, 1755, made itself felt in Munich: on a perfectly calm and sunny autumn day, a violent shock lasting for a second or two overthrew garden-walls, and disturbed the roof of a church, while windows in every direction flew open. A couple of days later an after-shock took place at 7 a.m. In August, 1769, there was a violent earthquake, which appears to have caused a certain amount of damage. Its epicentrum is shown to have lain beneath the Ries district, between Donauwörth and Harburg, where the Wörnitz fault-fissure intersects the Danube fault. The most considerable earthquake that affected Central Europe in the nineteenth century, was the Valais earthquake of July 25th, 1853, and its effects extended far beyond the Lake of Constance into Bavaria.

In 1904, 6 shocks were recorded at different Bavarian localities in January, 7 or 8 in February, 4 in March, 2 in April, 1 each in May, June and August, while July and September were felicitously free from earth-tremors. But in October, 4 shocks were recorded; in November, 3; and in December, 1. No serious consequences ensued in any case, though some of the shocks were violent enough to cause considerable alarm, and to rouse people from their sleep. At Bischofshofen, shortly before 2 a.m. on December 9th, an earthquake lasting about 2 seconds, accompanied by a thunderous rumbling, and travelling from west to east, caused cracks to make their appearance in the walls of several houses, and at Werfen articles placed on shelves, etc., were dashed to the floor. L. L. B.

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The region bordering on the Eastern Baltic represents in reality only the peripheral portion of the area affected by the earthquake which took place in Scandinavia and Denmark early in the afternoon of October 23rd, 1904, and made itself felt as far as Finland and St. Petersburg. Slight tremors having been observed about 12·30 p.m. on that day (St. Petersburg time) in various parts of the city of Riga, the author attempted, with the aid of the local press, to secure records of the occurrence in so far as it affected the Baltic provinces of Russia. He received in all 97 reports applying to 25 localities; but there is reason to believe that, as a matter of fact, the earthquake was observed in a far greater number of localities.

Beginning with Courland, in some houses in Libau, the floors swayed sufficiently to cause the inhabitants to spring in affright from their seats and to have a passing sensation of dizziness; chandeliers swung to and fro, crockery started clattering, and so forth. All this lasted for only about ½ minute, and the information as to the direction of travel of the earthquake is conflicting. Similar accounts came from Windau (where a high tower was seen to sway very perceptibly) and from other localities in the province.

From Riga, the author obtained 57 reports, and it is noticeable that the earthquake was less felt in those quarters of the city where low wooden houses predominate. Most of the observations, too, were made by persons who were in the upper stories of a building, the vibrations being apparently less perceptible on the ground-floor. Almost all agree in describing the motion as wave-like, rather than saltatory or jerky. The swaying of floors, the swinging of chandeliers, the movement of various objects of furniture, and so on are described, but there does not appear to have been any damage worth noting done to property. In some cases, persons rushed out of their dwellings under the impression that these were toppling down, and were too frightened to re-enter them for some considerable time. Careful investigation shows that the direction of travel was from north-north-west to south-south-east. Similar accounts reached the author from other localities in Livonia, and also from the neighbouring province of Esthonia.

After-shocks were observed at Dorpat on October 26th, at Reval on October 27th, and again at Dorpat on November 2nd.

No sound was heard accompanying or preceding this earthquake in the region of the Baltic provinces, and no particular relationship can be discerned between the geological structure of the country and the intensity or mode of propagation of the shock. The author summarizes the facts sifted out by him, as follows: in the course of a few seconds, several macroseismic waves separated by short intervals travelled through the Baltic provinces; microseismic movements preceded them by about 2 minutes, and followed them during about 17 minutes. The attendant circumstances reported by various observers would make the intensity range between 3 and 6 of the De Rossi-Forel scale, another proof, in the author's view, that the characterization of the degrees in that scale corresponds but little with the actual facts as observed in earthquake-occurrences.

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(2) *Beobachtungen in Upsala bei dem Erdbeben am 23. Oktober* 1904. *By* PER STOLPE. *Bulletin of the Geological Institution of the University of Upsala*, 1905, *vol. vi., pages* 200-213, *with* 1 *figure in the text.*

The Upsala earthquake of October 23rd, 1904, was one of the most violent and the most widespread that has occurred in Scandinavia within historic times. The epicentrum lay somewhere off the western coast of Sweden, and therefore at some considerable distance from the University town of Upsala. But the value to be attached to the records of an earthquake depends far less on the proximity of the observer to the pleistoseismic area than on his qualifications for, and experience in, exact observation; and a greater number of observers thus qualified, provided in some cases with the necessary recording apparatus, is likely to be found in a University town than elsewhere.

According to the seismograph set up at the Upsala Observatory, the first vibration made itself felt at 11·29 a.m., but out of the 82 statements sent in from various quarters of the town many differ in regard to the exact time. The motion is described as undulatory, the saltatory motion being by comparison imperceptible, on account of the great distance of Upsala from the epicentrum. It would seem that there were really two shocks, the latter of which was the more violent, separated by an interval of 8 or 10 seconds, and the total duration was something between 15 and 17 seconds. The direction of travel was approximately from west to east. Very few persons noted an "earthquake-sound" accompanying the shocks, but those that did so mostly describe it (in the usual fashion) as resembling the noise of a heavy cart rumbling along the street, or like a high wind banging against the windows and bursting into the room, or like the thud of a heavy falling mass, or the dull roar of distant artillery. However, in view of the small percentage of these observers compared with the number who heard no such noises, the author is disinclined to accept as a fact the statement that the shocks were preceded or accompanied by a true earthquake-sound. The motion induced in some persons a feeling of dizziness and nausea, windows clattered, doors were thrown open, tables rocked, mortar came rattling down from the walls, and so forth, but no damage of any consequence appears to have resulted in Upsala.

The stratigraphical conditions do not appear in this case to have had any influence in determining locally the degree to which the shocks were felt. At the Observatory, built on solid rock, out of 10 persons present, not one felt the vibration; from a quarter built on thick deposits of clay, the accounts received vary in the most irregular fashion; from the quarter nearer the railway-station, where the clays thin out, and rock comes to the surface, several negative reports were received. For this and other reasons the author concludes that earthquake-motion is of so complex a nature, and is so little influenced by factors which one would otherwise regard as determining factors, that we must still consider our knowledge of seismic phenomena as very rudimentary. L. L. B.

THE MACEDONIAN EARTHQUAKE OF APRIL, 1904.

Berichte über das Makedonische Erdbeben vom 4. April 1904. By PROF. R. HOERNES. *Mitteilungen der Erdbeben-Kommission der kais. rlichen Akademie der Wissenschaften in Wien*, 1904, *new series, No. xxiv., pages* 1-54.

Despite the opinion expressed by the officials of the Imperial Seismological Observatory at Strasburg, that the records furnished by seismographic

apparatus at stations situated some distance away from the *locus* of an earthquake are likely to be more accurate, in regard both to time and number of shocks, than the data supplied by observers on the spot, the author thinks it advisable to tabulate the best determinations of time that he could obtain from the pleistoseismic area of the great disturbance of April 4th, 1904. He regards them as approximately accurate, although they do not chronicle the actual beginning of the earthquake, but rather the more violent phase of it, perceptible to the ordinary senses of man. At Salonika, on the day in question, a fore-shock seems to have been felt about 5 a.m., followed by the two principal shocks at 11·36 and 11·58 a.m. respectively, and these by two feeble after-shocks at 1 and 1·25 p.m. respectively.

The reports concerning the earthquake, sent from the various stations to the superintendent of traffic of the Oriental Railways, are reproduced in full. On the whole, they agree that the interval which elapsed between the two principal shocks was about 22 minutes, but there are local discrepancies which lead one to suspect, either that the shocks started from different foci, or that their velocity of propagation was dissimilar or unequal.

The author arrived at Salonika on April 11th, in order to investigate the circumstances of the earthquake on the spot. The Turkish authorities gave him every facility, and he travelled about in Macedonia for several weeks, making his final report to the Vienna Academy on June 9th. Therein he traces the earthquake to a fault-line striking north-north-west and south-south-east between the Perim Dagh and the Maleš-Planina. This fault-line is marked out by a whole series of thermal springs, which can be followed from Demir-Hissar on to Džuma-i-Bala: at the latter locality the springs attain a temperature of 167° Fahr. The actual focus of the shocks seems to have lain below the Kresna defile, which is walled in by the two granite-ranges of the Perim Dagh and the Maleš-Planina above-mentioned. Here the roadway was mostly destroyed, the talus-slopes were tumbled into chaos, and great masses of rock in place were hurled down. The villages of Krupnik and Simitli, near the northern end of the defile, were laid in ruins; and much havoc was caused in other villages throughout the vilayets of Salonika and Kossovo. At Salonika, 81 miles away in a south-south-westerly direction from the epicentre, many houses were badly damaged, and a schoolboy was killed by falling débris. At Vranja in Servia, 83 miles away to the north-west, and at other localities similarly distant to the west-south-west and south-east, great damage was done; as also at the famous monastery of Rilo in Bulgaria. The propagation of the earthquake was, however, so extremely irregular, that the author regards the endeavour to plot out the isoseismals on a map as quite hopeless in this case. As to determinations of intensity, based as they usually are on the amount of damage done to buildings, these are attended with considerable difficulty in Macedonia. Some houses are so built as to collapse at the least shock (walls of sun-dried brick with very heavy, broad-eaved and tiled roofs); while others withstand, all but undamaged, the most violent earthquakes: these latter are timber or frame-houses. The fact, however, remains that a very large number of buildings were completely destroyed, or rendered uninhabitable, in all the villages bordering on the focal or epicentral area. The time at which the earthquake took place, and the interval of 22 minutes between the first principal shock and the second (and more violent one), allowed of the villagers seeking safety in flight, and thus the loss of life was fortunately inconsiderable.

It is noticeable that the villages built on the older rocks suffered far less than those situated in the Strumica plain on the north, and on the other side of the Vardar valley. Moreover, localities lying along east-and-west fault-lines suffered less than those lying along north-north-westerly and south-south-easterly fault-lines. Other local differences in the effects of the earthquake are traceable to the nature and lie of the rocks; but even this statement admits of exceptions.

After-shocks seem to have gone on, for several weeks on end, in the Kresna defile. New thermal springs welled forth in various places, and during the earthquake the flow of water increased in the already-existing hot springs. The same is reported of several cold springs; while, on the other hand, some cold springs ceased flowing altogether. In the lowlands, chasms were opened up in the alluvial deposits, and through these chasms water and mud were spurted up in many cases with considerable force; the Struma valley between Krupnik and Simitli furnished the most impressive examples of this phenomenon.

It is to be noted, in conclusion, that, on previous occasions, violent earthquakes have started from what is believed to be the same focus as that whence originated the earthquake here described. L. L. B.

THE EARTHQUAKE OF 1905 IN THE KANGRA VALLEY, HIMALAYAS.

Das Erdbeben im Kangra-Thal (Himalaya) vom 4ten April 1905. By E. Kokes and F. Noetling. *Centralblatt für Mineralogie, Geologie und Paläontologie*, 1905, *pages* 332-340, *with a map in the text.*

On April 4th, 1905, the Kangra valley in the Western Himalayas was visited by an earthquake, comparable in its disastrous effects with that which wrought havoc in Assam on June 12th, 1897. From the material at the authors' disposal they are enabled to plot out on the map four distinct areas, classified as follows:—(*a*) Pleistoseismic area; (*b*) area wherein the shocks were still very violent, and a certain amount of damage was done; (*c*) area wherein the shocks were but little felt; and (*d*) area within which the earthquake was perceptible to seismographic recording instruments alone. (*a*) As most newspaper-readers already know, the scene of greatest destruction was the fertile Kangra valley, a favourite summer resort with the Anglo-Indians of the Panjâb. The town of Kangra itself, situated at an altitude of 4,300 feet above sea-level in the Banganga glen, was completely destroyed, and out of its population of 4,700 souls not less than 4,000 perished. At Dharamsala, 16 miles to the north-east, only 390 persons were saved out of 3,000 inhabitants. It was here that the Gurkha barracks were razed to the ground. The small town of Pathankote, 40 miles west of Dharamsala, and five villages (which are named) were also completely destroyed.

Area *b* included Simla, Mussuri (where a number of persons were killed, and enormous damage to property was done), Dehra Dun and Lahore. Area *c* covered the entire Panjâb, and extended through Agra and Allahabad to beyond Calcutta. In area *d*, the seismograph at Bombay, about 5·45 a.m., on April 4th, registered a considerable seismic disturbance, the epicentre of which was estimated to lie some 700 miles away (the actual distance from Dharamsala, as the crow flies, is 800 miles). The earthquake was not perceptible in Central India, Assam or Burma.

The pleistoseismic area covers an ellipse, the major axis of which extends east-south-eastward for 80 miles, while the minor axis measures 30 miles. Within this elliptical area not a single house remained standing, but it is curious to note how rapidly the intensity of the earthquake diminished outside this area. Thus, at Dalhousie, 35 miles north-west of Dharamsala, the shocks were but slightly felt, and the same observation applies to the whole of Kashmir. The seismic waves seem to have been checked north-westward, and the principal direction of propagation was south-eastward, combined with a simultaneous westward deviation into the Indo-Gangetic plain. At Lahore, 130 miles distant, as the crow flies, from Dharamsala, and therefore somewhat farther away from the epicentral area than Simla, the damage done by the earthquake appears to have been more considerable than in the last-named locality, while the neighbouring city to Lahore, Mian-Mir, escaped with but little damage. Amritsar too, equidistant with Simla from the epicentre, suffered hardly at all. The result is that area *b* assumes on the map a curiously crescentic shape, the pleistoseismic area (*a*) lying within the hollow of the crescent, one horn of which trends 180 miles south-eastward parallel with the strike of the mountain-ranges, while the other horn trends 130 miles south-westward perpendicular to the strike of the mountain-ranges.

The velocity of propagation of the earthquake, assuming that it started at 6·9 or 6·10 a.m. at Dharamsala, and seeing that the first vibration was registered by the seismographic instruments at Calcutta at 6·50 a.m., must have been about 26 miles a minute, or 2,296 feet per second. But this does not tally with the Bombay record, which, allowing for difference in time-reckoning, would make the velocity work out at 2·65 miles per second.

There seems to be no doubt that this disturbance falls within the category of tectonic earthquakes, and is not a simple uniaxial earthquake, but a biaxial one; that is, being originally uniaxial, it underwent in its north-western portion a westward deviation. The focus probably lay along the great fault-line which brings the Tertiary rocks of the Outer Himalayas plump against the rocks that form the core of the Central Himalayas. The first shock was succeeded by numerous less violent shocks, both on the same and on the following day.

In the early days of April, 1904, (from the 2nd to the 6th) earthquakes took place in Southern India, in the area of the Deccan massif. There is however, no trustworthy ground for connecting these with the Kangra earthquake, and Ongole, where they were chiefly observed, is known as a seismic centre, about three earthquakes taking place there every year on an average. L. L. B.

SEISMICITY OF THE SOUTHERN ANDES.

(1) *Les Andes méridionales sismiques. By* F. DE MONTESSUS DE BALLORE. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 1904, *vol. xviii., Mémoires, pages* 79-105 *and* 1 *plate ; and*

(2) *Sur les Tremblements de Terre des Andes méridionales. By* F. DE MONTESSUS DE BALLORE. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii. pages* 106-108.

The author has profited by the recent publication of Dr. Friedrich Goll's catalogue of the Chilian earthquakes to recast his own earthquake-map of the Southern Andes. From the seismological point of view, the southernmost province of Peru, Arequipa, is inseparable from the northernmost province of

Chile, Arica; and thus the area studied by the author extends along the western flanks of the Andes from 16° to 56° south latitude, along 2,500 miles of the Pacific coast-line. In that region, the Andes represent the dislocated and shattered rim of an uplifted slab of the earth's crust: on the east, this slab was merely flexured; wherefore high relief and steep slopes are characteristic of the Pacific side of the range, and, with one single exception, seismic disturbances are confined to that side. Even so, they occur only where the above conditions hold good, between the summits of the range and the isobathic contour of 13,200 feet. This isobath, running parallel and near to the coast, represents the base of the Cordillera, which may be regarded as submerged to about one-third of its total altitude. At Valparaiso, the only point where this isobath actually touches the shore, there is a notable accentuation of the seismic phenomena. The southern pampa of Tamarugal, the Antofagasta desert, and the northern part of Atacama, in fact, nearly the whole nitrate-region, correspond to a broadening of the chain into a series of steps: and here a corresponding diminution of the seismic phenomena is observable.

Within the great belt, mapped by the author, seven separate regions of seismic instability are recognized, comprizing 120 epicentres, with 8,027 recorded shocks. To these seven must be added an eighth—the neighbouring belt of ocean, where at least 28 submarine shocks, not simultaneously recorded on the adjacent land, have been observed. The annual frequency of shocks within the entire area, calculated from the records, amounts to 162, a figure which is probably much too small. The fact that a large proportion of the earthquakes appear to have originated between the coast and the isobathic contour of 13,200 feet confirms the inference of a causal connection with the tremendous line of fracture along which the Andes were being upheaved, from Jurassic until late Tertiary times. We may note, too, the gradual eastward slope of the Andes to Bolivian and Argentine territory, which includes regions of infinitely greater seismic stability than those just considered. The great movement of upheaval appears to have ceased sooner in the south than in the north, and was, in any case, of less magnitude in the south, as witness (1) the lower altitudes of the Cordillera in the Magellanic region, coincident with a comparative shallowing of the sea; and (2) the marked southward diminution of normal instability from Valparaiso to Puerto Montt (the seismic disturbances of Talcahuano and Valdivia must be regarded as assuming an exceptionally paroxysmal character). From the latitude of Talco onwards seismic movements practically cease until Cape Horn is reached. The change in direction of the mountain-range takes place gradually, and without any particular dislocation, so that earthquakes are not more frequent at Arica than in a belt of some 180 miles on either side of the coast-line, and they are less frequent at Tacna than inland. There is no trustworthy evidence in favour of the hypothesis that the slow upheaval of the Andes is still going on.

The main conclusions are that (1) the earthquakes which take place in the Southern Andes are the ultimate and indirect result of the uplift of the chain and the accompanying dislocations. This is the more evident that they are unknown in Patagonia, the Pampan strata of which prove by their horizontality the greater remoteness in time of a check in the ascensional movement of the Cordillera in that region; (2) a perfect analogy is traceable between the tectonic phenomena in the South Andean belt and those which have given rise to seismic instability along the southern flanks of the Himalayas: along these, too, a whole continent, the ancient Gondwanian

continent, sank, the difference being that, in India, the great fracture-line is masked by the enormous alluvial accumulations of the Indo-Gangetic plain. Just as Bolivia and the Argentine, so is Tibet a region of comparative seismic stability; (3) all the facts observed show that all degrees of seismic instability are compatible with either the presence or the absence of volcanoes, with either active or extinct vulcanicity. Once more it is seen that the two orders of phenomena are completely independent of each other, both in time and space; and (4) it may be noted, however, that, in the Southern Andes, as in the Caucasus and other mountain-regions, seismic instability reigns at the base of the rim of the upheaved belt, and volcanic activity at its summit.

Statistics are given of earthquakes and tidal waves, as also a catalogue of annual frequencies of earth-tremors, from the year 1811 to 1902 inclusive, in the area with which the two papers especially deal. L. L. B.

SEISMICITY OF THE CARIBBEAN AREA.

Les Relations sismico-géologiques de la Méditerranée antillienne. By F. DE MONTESSUS DE BALLORE. *Memorias de la Sociedad científica "Antonio Alzate,"* 1904, *vol. xix., pages* 351-373 *and* 1 *plate.*

The sea to which the author applies the name of the "Antillean Mediterranean" is bounded by the Greater and Lesser Antilles on the north and east, by Venezuela and Colombia on the south, and by Central America on the west. Its margins especially, if we except the western side, have been frequently devastated by earthquakes of great violence, some of which have proved almost as destructive as the terrible catastrophe that overwhelmed St. Pierre de la Martinique in 1902. The broader aspects of the geology of the region are now becoming pretty well known, and the author here sets forth the results of an investigation into the connection between its chief geographical and geological features and the distribution of seismic instability within this region.

Use has been made of the records of no less than 3,416 earthquakes, which have been traced to 169 terrestrial epicentra. The region is divisible into five distinct areas, the first to be dealt with being that of the Bermudas and the Bahamas. The geological structure of these two groups of islands, despite the great distance that separates them, is sufficiently similar to permit of their correlation. No considerable change of level has taken place there since the year 1609, but submarine shocks have been noted all around the Bermudas. Such earthquakes as have been recorded are of low intensity, and their origin may be sought as far back in geological history as the age following on the close of the Tertiary era.

The Bahamas, poised on the very edge of a great submarine slope going down to depths of 16,200 feet and more, are the fragmentary remnants of the prolongation of the vast Tertiary plain of Florida, from which they were split off at a comparatively recent period, although the author remarks that the work accomplished by the reef-building corals "is tending to reconstitute territorial unity." We cannot point to any seismic phenomenon proper to the Bahamas; and, in fact, they constitute, in company with the mainland areas of Florida and Yucatan, an area of quite uncommon seismic stability. The key to this is found in the absence of geologically recent dislocations in the area.

The second group includes the Greater Antilles: Cuba, Jamaica, Hayti, Puerto Rico, and the Virgin islands, forming the northern margin of the Caribbean sea. With the exception of Cuba (the two extremities of which alone are seismically unstable), all these islands have been visited, at one time or another, by great seismic catastrophes, and the frequency of fairly serious earthquakes is considerable. These islands exemplify in the very highest degree the geophysical conditions which are associated along so many shore-lines with great seismic instability: namely, oceanic abysmal areas, the result of subsidence at no very remote period, margined by the precipitous walls of an ancient and partly dismantled mountain-range, which is itself abutted on the other side by more recent sedimentary formations, Secondary and Tertiary; these were thrust up against the range as a consequence of its upheaval, the counterpart of the submarine subsidence. The earthquakes are the indirect results of these gigantic movements, and are directly connected with the dislocations caused by these movements within the ancient mountain-range and the contiguous sedimentary formations. The upheaval is presumed not to date farther back than the end of the Miocene period. These great vicissitudes of the northern margin of the Caribbean sea were unattended by volcanic phenomena, and here we have again an example of the mutual independence of vulcanicity and seismicity. Their common origin is not thereby excluded; but, as different consequences of the same causes, they may occur in conjunction, and, equally, they may not.

The third group formed by the Lesser Antilles, closes in the Caribbean sea on the east by an almost unbroken chain of islands (most of which are of volcanic origin), describing a curve which is slightly concave westward. They are closely margined by the isobath of 6,600 feet, which opens out, however, northward; while the isobath of 13,200 feet is 185 miles distant on the Caribbean side, and 95 miles distant and more, on the Atlantic side of them. These soundings show that here is a long and narrow ancient ridge, which in Secondary times was connected with the South American continent and emerged above sea-level, with the exception of two straits, respectively north and south of Martinique. Volcanic activity has had much to do with the building up of the Lesser Antilles, but in most of them has now reached the solfataric stage, and the phase of massive lava-flows may be regarded as having generally come to an end therein. Thanks to the diversity of earth-movements in this area—very recent upheavals, less recent subsidences, etc., the islands are in a condition of extremely unstable equilibrium, although the geological vicissitudes which they have undergone are not comparable in magnitude with those through which the Greater Antilles have passed. The latter islands are of solid build in comparison with the Lesser Antilles, which are so largely made up of volcanic ejectamenta heaped up confusedly without much cohesion: hence the earthquakes that shake the Greater Antilles are probably in reality much more violent than those which are sufficient to bring devastation to the Lesser.

It is noticeable that, during the four centuries that have elapsed since Columbus set foot in the West Indies, few really submarine shocks have been recorded in the Caribbean sea. The tidal waves that have been recorded in Jamaica, Hayti, on the southern coast of Puerto Rico, and around the Virgin islands, are presumably due to shocks propagated from epicentra very near the coast, if not actually terrestrial. Like the Western Mediterranean, the bottom of the Caribbean sea is apparently a region of perfect seismic stability. East of the Lesser Antilles, however, numerous submarine

shocks have been observed extending far out into the Atlantic, and the southern half of that archipelago is especially affected by tidal waves. The more one considers the facts, the more the contrast between the Greater and the Lesser Antilles becomes evident; and the latter islands are seen to be the western rim of a seismically unstable region, the eastern boundary of which may lie well beyond 40° west longitude.

The fourth area includes Venezuela and Lower Colombia, extending from the islands of Tobago and Trinidad to the isthmus of Darien. Seismically, perhaps, the least unstable portion is Lower Colombia, while between Spanish Town and Cumana stretches a belt of extreme instability. Highly unstable, too, are the Caracas massif and the Sierra de Merida, while the great Jurassic, Cretaceous and Tertiary plain of the Llanos is characterized by almost complete immunity from earthquakes.

The fifth area, covering the eastern coast of Central America, is one of seismic stability, contrasting sharply with the western coast which is frequently devastated by earthquakes. In pre-Cretaceous times, Central America formed a group of islands, separated from each other and from the northern and southern continents by the three straits of Darien, Panama and Tehuantepec. A movement of upheaval turned these straits into isthmuses at the very time when the Greater Antilles were being broken up by an inverse movement of subsidence.

The memoir, the dominating idea of which appears to be the demonstration of the connection between earthquakes and the tectonics of the region in which they occur, is accompanied by a catalogue of the 169 epicentres previously mentioned and the shocks traceable to them, as also a list of the submarine shocks observed in the Western Atlantic, etc.

L. L. B.

SEISMICITY OF THE ISLAND OF AMBON, DUTCH EAST INDIES.

(1) *Geologische Beschrijving van Ambon: Aardbevingen te Ambon.* *By* DR. R. D. M. VERBEEK. *Jaarboek van het Mijnwezen in Nederlandsch Oost-Indië*, 1905, *vol. xxxiv., Wetenschappelijk Gedeelte, pages* 264-308, *and* 9 *plates.*

(2) *Tremblements de Terre à Ambon.* *By* DR. R. D. M. VERBEEK. *Description géologique de l'Île d'Ambon*, 1905 (French edition of the *Jaarboek van het Mijnwezen in Nederlandsch Oost-Indië, vol. xxxiv., Wetenschappelijk Gedeelte*), *pages* 278-323 *with* 6 *figures in the text, and* 5 *diagrams and maps.*

Premising that Batavia is the only locality in the Dutch East Indies where proper seismographic instruments are available for the recording of earthquakes, the author points out that reports in any wise detailed as to the shocks felt in the island of Ambon are practically confined to the most violent earthquakes, such as have wrought havoc in districts inhabited by Europeans. Little is known regarding the numerous shocks to which the island was subject in remote ages, but from the data that he has been able to collect, the author deduces one important conclusion, namely, the recurrence of two categories of earthquake in Ambon; in the first the shocks travel from north-east to south-west, while in the second they take a direction all but perpendicular to the first. In this connection he lays stress on the fact, that, unlike "volcanic earthquakes," wherein the motion usually starts from a single point, the Ambon shocks are purely "tectonic earthquakes," wherein the motion starts from several points or from a plane, the originating cause being dislocation and sagging along fault-lines.

A catalogue is given of the earthquakes recorded in the island and in

the neighbouring seas, from the year 1629 down to October 13th, 1903. Full descriptions are given of the most notable of these, namely, the earthquakes of 1644, 1671, 1674, 1754 and 1835, abridged from the accounts of various authorities named by the author; and he then proceeds to describe the disastrous earthquake of January 6th, 1898, into which he was commissioned to enquire about two months after the event. Lapses of memory and want of precision in observing faculty probably account for the conflicting evidence which he received from various eye-witnesses; but he was enabled to check and to correct it to some extent by means of the investigations which his colleague (Mr. Koperberg) and himself carried out on the spot. No fore-shocks seem to have been noticed before the fatal day, but a few "up-and-down" shocks were felt at about half-an-hour after noon, three-quarters of an hour before the principal shock. Devastation was greatest in a belt some 2½ to 2¾ miles broad, stretching across the island from north to south. The havoc wrought at Wakal (on the northern coast of the Hitu district) and at the town of Ambon (on the northern coast of the Leitimor peninsula) was considerable; it was along the line joining those two places that the disturbance was most violent, the shock being felt with ever-decreasing intensity in proportion to the distance at which the observer was stationed east or west of that line. Great landslips were found to have taken place in uninhabited portions of the Hitu district, and also between Ambon city and Rupang bay on the southern coast. In this latter area, the slips of Quaternary strata and decomposed granite were sufficient to make many of the roads impracticable; but, all the same, the devastation was not so great as in the north, owing doubtless to the fact that the superficial deposits are here underlain by a granitic massif. We see then, that unlike the circle or ellipse with which seismologists are familiar in so many other earthquakes, the form of the pleistoseismic area in this case was merely that of a long, comparatively narrow band, another indication of its tectonic origin. It was, in fact, due to fresh dislocation along a pre-Cretaceous fault-fissure, which extends right across the island from Rupang bay to Wakal (where the effects of the shock were most felt), and probably farther still, by Piru bay to Little Ceram. The epicentrum lay somewhere below Wakal, or a little to the north of it, and the direction of travel is shown to have been from north-west to south-east. In Ambon city, a great many buildings were destroyed and no less than 441 persons were buried beneath the ruins, 141 of whom perished. It was then proposed to move the seat of government to Amahei, a plain only a few feet above sea-level, on Elpaputi bay, in Ceram. The author was fortunately successful in impressing the officials with the disadvantages of this course; for, on September 30th, 1899 (that is, some 18 months later), a great portion of Amahei was overwhelmed by a tidal wave, and 350 persons were drowned.

In addition to the principal shock, secondary shocks took place, the pleistoseismic areas of which are mapped out as belts extending from west to east, along the northern and southern coasts of the island. Many buildings were destroyed or damaged, but no mention is made of injury to life or limb. These secondary shocks are traced to fault-lines which run near both coasts, more or less perpendicular to the Ambon-Wakal fault. It should be mentioned, in regard to the principal earthquake, that a vertical motion (much more violent at Wakal than at Ambon city) was superadded to the horizontal, undulatory motion. The only portion of the neighbouring seas where the seismic phenomenon made itself felt, and then but feebly, was Ambon bay.

L. L. B.

ORIGIN OF COAL, SPONTANEOUS COMBUSTION AND FIRE-DAMP.

Einiges Neue über die Entstehung der Mineralkohlen und ihre Selbstentzündung, sowie über die Schlagwetterexplosionen. By F. JANDA. *Österreichische Zeitschrift für Berg- und Hüttenwesen*, 1903, *vol. li., pages* 326-329, 344-346, 355-359, 376-377 *and* 388-391.

Coal is a rock of organic origin, containing oxygen, carbon, hydrogen, and other constituents. If air be admitted to vegetable substances, when at a high temperature, they take up oxygen and are gasified; and if heat be applied without air, as in a retort, the hydrogen and oxygen are driven out, and the carbon remains. This process is known as dry distillation, and in this way coal has been formed from land- and water-plants, especially the latter. The clay-slates, containing mica and potash, afforded a rich soil, and the moisture in the air fostered the growth of the plants. As the more perishable decayed, they furnished nitrogen to plants of higher organisation such as *Sigillaria* and *Lepidodendra*, in which the Coal-measures are rich. A subtropical climate, with a temperature of 68° to 77° Fahr. seems to have been universal, and an atmosphere charged with carbon dioxide and water-vapour. To secure this moderate and equally diffused warmth, it has been supposed that the climate was independent of the earth's position towards the sun, and that the inclination of its axis was not so considerable as it is now. This luxuriant vegetation was probably transformed into coal in its original position. In the Secondary or Liassic era, forming the transition between the Primary, when stone coal, and the Tertiary, when brown coal and lignite were produced, the flora is chiefly coniferous. The land passed from a marshy to a dry condition, and hills and valleys appeared. In the Tertiary age, there was little extension of the coal-measures. The atmosphere seems to have been charged with marsh-gas, causing frequent conflagrations. During this period, sandy and argillaceous strata were deposited, between which brown coal is chiefly found, usually in folds that had been swept over by currents of fresh water.

When air reaches a dead plant, and it cannot be gasified by oxidation, a substance known as humus, containing carbon and lime, is developed inside the plant-cells. Humus is found in peat, and it is in the growth of peat, in which bubbles of carbon dioxide and marsh-gas rise to the surface of bogs and burst, that the formation of coal may still be studied. In the process of carbonization, the gases of marsh-plants, hydrogen, oxygen and their compounds, were driven off, and this is still going on in coal-mines; in the later brown coal-seams, carbon dioxide, and in the earlier stone coal-seams, marsh-gas was liberated. Upon this fossil and carbonized vegetation, strata of clay and sandstone supervened, heat was generated, the pressure was high, the water rapidly driven out, and dry distillation with decomposition took place. The slower the process, the poorer was the coal in oxygen and hydrogen, and the richer in carbon. Geological upheavals, dislocations, faults, etc., caused different degrees of carbonization, and where the pressure was greatest the coal was converted into anthracite. Bituminous coal is of later formation, and brown coal still more recent. The quality and heating value of the latter varies greatly, showing that it was carbonized at different stages, but all brown coal is low in carbon, and contains a high percentage of water and ash. Lignite, the latest of all coal, still retains its woody structure.

The origin of coal and peat has been ascribed to fermentation, and a certain similarity in the process of generating alcohol and stone-coal, and

in the products, has been pointed out. The writer considers that this applies only to the earlier stages in the formation of coal, and that the temperatures attained are too high to allow of the working of fermentation-agents.

The spontaneous combustion of coal cannot take place without heat, and the presence of oxygen or air, and the process of generating the one and absorbing the other is known as oxidation. Heat is a movement of atoms and molecules, increasing their distances from each other, and the marsh-gas, carbon dioxide and nitrogen, enclosed in the pores of the coal, are liberated. Pyrites, in the coal, also favours spontaneous combustion. It is oxidized into sulphurous and sulphuric acids, the heat developed by chemical action dries and heats the coal, and if air be admitted it ignites and burns.

Coal absorbs atmospheric air, condenses it, and increases in weight; while, if disintegration continues, the weight falls, carbon dioxide and hydrogen are set free, and the heating value of the coal is reduced. The capacity of a given coal for spontaneous combustion may be determined by the amount of bromide with which it is able to combine. The chief substances in the coal which contribute to combustion by their readiness to unite with oxygen are the hydrocarbons, and the oils produced during natural decomposition.

The Société Belge de Géologie, de Paléontologie et d'Hydrologie has directed special attention to the study of gases in mines. The laws governing the periods of explosions of fire-damp have received considerable notice, and it has been proved that seismic disturbances precede issues of fire-damp or mine-gas. It is the mine-gas in the pores of the coal, set free when the barometric pressure is low, that constitutes a serious danger to the miner, and requires careful study. E. M. D.

A RECENT FORMATION OF THE CANNEL-COAL TYPE.

Eine rezente organogene Schlamm-Bildung des Cannelkohlen-Typus. By H. POTONIÉ. *Jahrbuch der Königlich Preussischen Geologischen Landesanstalt und Bergakademie zu Berlin*, 1904, *vol. xxiv.*, *pages* 405-409.

In the neighbourhood of the Neuwarper see, an arm of the landlocked Stettiner haff, lies the Ahlbeck marsh, an ancient lake, in part silted up, in part artificially drained. There is here a typically "shaly peat," consisting chiefly of the compressed remains of aquatic organisms, both animal and vegetable. The animal-remains are predominantly crustacean, and among the plant-remains, contrary perhaps to expectation, bacillariaceæ are comparatively infrequent. The author proposes to distinguish a formation of this kind from the ordinary true peat by the designation of *faulschlamm*, which is hardly translatable into English except by a paraphrase, as it conveys the idea both of decomposition or rotting away and of muddy or slimy deposit.

Dredging along the Neuwarper see, to the point where it debouches into the Stettiner haff, revealed everywhere the presence of a deposit of *faulschlamm* many feet thick; fishermen say that at some points it attains a thickness of 40 feet or more. Microscopic examination shows it to be essentially identical with the deposit above described in the Ahlbeck marsh. In fact, *faulschlamm* is of very frequent occurrence in tranquil waters (even in bays along the coast) all over Northern Germany.

It may be described as an aquatic autochthonous deposit, formed in stagnating waters, out of the remains of the creatures that lived in those

waters; of course, mineral particles, such as grains of sand blown into the water by the wind, and fragments of plants growing on the shore, contribute a small quota to such a deposit. Its organic composition is precisely that of the Palæozoic cannel and boghead-coals, and of many bituminous shales. So too, bituminous limestones are of similar origin: in the Ahlbeck marsh, below the *faulschlamm* proper, occurs a calcareous deposit of *faulschlamm*-limestone. L. L. B.

THE FORMATION OF PETROLEUM AND ITS CONGENERS.

Zur Frage nach den Ur-Materialien der Petroleu. *By* H. POTONIÉ. *Jahrbuch der Königlich Preussischen Geologischen Landesanstalt und Bergakademie*, 1904, *vol. xxv., pages* 342-368, *with* 1 *figure in the text.*

Pursuing his investigations into this subject, some of the fruits of which have already been published, the author reminds us that the chemical peculiarities of the products arising from decomposition pure and simple taking place under water are dependent, not only on variations in the process, but on the original chemical character of the decomposed organisms.

In the case of peat-formation and analogous processes the residual products, very rich in carbon, are essentially compounds of carbon, hydrogen and oxygen, so constituted as to suggest that they are in a sense dehydrated carbohydrates. On distillation, they tend to yield compounds of the aromatic group, such as benzol and its congeners, while those richest in carbon form compounds of the paraffin-group.

In the case of sapropel, a term of Greek derivation proposed by the author to cover those slimes or muds which ultimately result from the rotting-away *in situ* of aquatic organic material, the residual products are also made up of carbon, hydrogen and oxygen, but are not so rich in carbon as those yielded by the ordinary process of peat-formation, while they are richer in hydrogen. On distillation, sapropel-deposits tend more especially to yield compounds of the methane-group and naphthenes. Sapropel, at a later stage of the memoir, is described as a grey-brown, greenish slime, occurring in deposits which may reach many feet in thickness.

Wherefore the author ranges peat-formation under the processes incident to carbonization, and classifies the sapropels as arising from bituminization. The sapropels are essentially primary deposits, whereas many of the bituminous rocks (as generally defined) are secondary deposits.

The author had already shown that the sapropel obtained from the Ahlbeck swamp, near Ludwigshof in Pomerania, is not a bacillarian mud, but is predominantly of animal and partly of vegetable origin (a zoophytogenic rock); and he now sets himself to prove that both animal organisms and aquatic plants (especially algæ rich in oil) are essential factors in the initiation of a petroliferous deposit. He lays stress on the fact that catastrophic destruction of organic life need not be postulated, to account for the known reservoirs of natural oil; but that the everyday continuous processes of nature yield a quite sufficient amount of the primary material of petroleum—which, in itself, is a secondary deposit. In addition to "sapropel" he proposes the use of the terms "saprocoll," "saprodil," and "sapanthrakon," the two last-named referring to fossil sapropels, such as cannel-coal, bituminous shales, etc. Definitions of these terms are given in a succinct form. Some authors believe that petroleum can only be derived from salt-water organisms, but this opinion is shown to be erroneous.

L. L. B.

GRAPHITE IN THE PÖCHLARN GRANULITE, LOWER AUSTRIA.

Graphit im Granulit bei Pöchlarn. By ALOIS SIGMUND. *Tschermak's Mineralogische und Petrographische Mittheilungen*, 1904, *new series, vol. xxiii., pages* 406-409.

Until now, the belief has prevailed that the occurrences of graphite in Lower Austria are confined to certain gneisses and the accompanying crystalline limestones; and that, in particular, the granulite-masses intercalated among these gneisses are completely barren of graphite. Graphite, however, has been found, both in the form of isolated flakes and in dust-like films and aggregates of flakes, in a granulite, quarried for road-metal, in a flat-topped, dome-like hill, rather more than 1¼ miles east of Pöchlarn, near the right bank of the Danube, and rising to an altitude of 330 feet above that river. In places, the graphite forms thin, lustrous layers coincident with the planes of schistosity of the rock; and sometimes the mineral is arranged in dendritiform groupings (which recall the more commonly known dendritoids of manganese), contrasting sharply with the white rock-matrix, and therefore seen from afar. Similar dendritiform aggregations of graphite have been found in the deeper parts of another granulite-quarry, rather less than 1½ miles south of Pöchlarn.

The data are adduced which have led the author to the conclusion that the graphite was solidified after all the other constitutents of the rock had solidified.

The graphite of Ceylon also occurs in granulites, but the pneumatolytic origin assigned by Dr. Weinschenk to that mineral will not apply to the Pöchlarn graphite. At Tsheremshanka, near Miask, in the Urals, little spheroids of graphite showing radial structure are disseminated in the granulites, and this occurrence resembles that of Pöchlarn in showing no connection in the form of veins between the isolated "nests" of graphite. In both these localities, then, unlike in Ceylon, the graphite, though a "late arrival" as a rock-constituent, appears nevertheless to be a primary constituent. L. L. B.

PERMIAN STRATA IN THE RAKONITZ COAL-BASIN, BOHEMIA.

Zur Kenntniss der Permschichten der Rakonitzer Steinkohlenablagerung. By FRIEDRICH KATZER. *Verhandlungen der k. k. geologischen Reichsanstalt*, 1904, *pages* 291-293.

An idea was prevalent at one time that the line of granite-heights trending north-westward, against which an extension of the Rakonitz Carboniferous belt abuts, marked a fault-line along which productive coal-measures might be struck deep below the surface. Careful investigation falsified this hope:—(1) A boring put down about ¾ mile north-east of the village of Kletscheding reached, at a depth of 235½ feet, a coal-seam barely 20 inches thick, and at 244 feet was stopped in fine-grained biotite-granite. (2) Another boring, put down south-east of Pschoblick, nearer the centre of the coal-basin, struck the same coal-seam at a depth of 295 feet, and was stopped in grey sandy clay-slates at 332½ feet.

These borings proved that: (1) There is in this area a universal north-easterly dip of the coal-bearing beds; (2) the basin in which they lie is itself inclined north-eastward, and it is quite within the bounds of possibility that yet another coal-seam, now unproved, may be struck in the

deepest part of the basin; (3) the author's attribution of the Pschoblick and Kletscheding measures to the Permian, or at the oldest to the Permo-Carboniferous system, rather than to the true productive Coal-measures, is upheld. There seems to be no doubt now as to the Permian age of the topmost red "beds" of the western rim of the Rakonitz basin. L. L. B.

URANIUM PITCHBLENDE-DEPOSITS OF ST. JOACHIMSTHAL, BOHEMIA.

Das Vorkommen des Uranpecherzes zu St. Joachimsthal. By J. Step and F. Becke. *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften (Wien), 1904, vol. cxiii., pages 585-618, with 4 figures in the text and 4 plates.*

The mining industry of the district occupies one of the deeply cut, north-and-south valleys, that are so characteristic of the southern slope of the Erzgebirge. On account of repeated inflows of water, the most serious of which took place in 1881, the deep-level workings of the eastern division were perforce abandoned, but mining operations were continued until the year 1900, at the higher levels. In the western division, to which access is gained by the Werner shaft, the workings have reached a depth of 1,364 feet from the surface. In the transverse valleys of Dürrnberg and Zeileisengrund, mines are also still at work; while, in enumerating the mines which are now abandoned, the authors mention that uranium-ore was never found in any of them.

There seems to be no doubt that the St. Joachimsthal ore-deposits are genetically connected with the granite-intrusions of the Western Erzgebirge; further, that the region had been an area of tectonic disturbance before the intrusion of the granite. The gneisses which form the mass of the Erzgebirge, east of St. Joachimsthal, dip westward beneath mica-schists, which farther north-westward again are overlain by phyllites. Both gneisses and mica-schists are considerably folded, and of the latter a detailed petrographical description is given. From the economic point of view, it will suffice here to note that, in contradistinction to the pale, muscovitic, frequently garnetiferous schists, poor in felspar, it is the dark, biotitic, felspathic, rarely garnetiferous, often somewhat carbonaceous schists, that are known especially as the Joachimsthal schists, and carry the best metalliferous veins. These veins again are richer in the soft, highly micaceous variety of the Joachimsthal schists than in the hard, "short-fissured," mica-poor variety. The mica-schists are traversed by porphyritic dykes, which are in all probability apophyses from the Neudeck granite-mass. To the vulcanicity of Tertiary times are assignable the dykes of basalt, and phonolite, and the masses of agglomerate which further characterize the district.

The metalliferous veins are divisible into two distinct groups: (1) The easterly veins, which strike about parallel with the mica-schists; and (2) the northerly veins, which practically cut that strike at right angles. The innumerable waste-heaps, characteristic of the outcrops of the first group, bear witness to their superficial wealth, although in depth they become, with but few exceptions, barren. Later in date than the porphyritic dykes, the metalliferous veins are nevertheless undoubtedly of earlier origin than the Tertiary sills and lava-flows.

Wherever, in the St. Joachimsthal district, uraniferous ores occur, they take primarily the form of pitchblende: the catalogue of other uranium-bearing minerals that could be drawn up from the district is, it is true, a varied one; but these are all of secondary formation, and industrially of no importance. A striking local characteristic is the invariable intercalation of uranium-ore between quartz and dolomite within the veins: in many cases there is, moreover, repeated interbanding of the ore with the dolomite, and in the immediate neighbourhood of the ore the gangue is always dolomitic. The distribution of the ore is very irregular, but there is a general tendency to enrichment near the foot-wall, and impoverishment near the hanging-wall of the vein. In addition to dolomite, the chief constituents of the gangue are marly decomposition-products of the country-rock, and calcspar and other carbonates.

Premising that the St. Joachimsthal ores, generally speaking, belong to the silver-cobalt group of the Erzgebirge complex, the authors point out that within this group the cobalt-nickel-arsenic minerals are undeniably of earlier formation than the silver-minerals. The chronological relationship of the uranium-ore to these is the more difficult to determine that the uranium-ore and its concomitants generally "dwell apart," so to say, from the other ores of the district; but such evidence as can be traced shows that the silver-minerals were deposited after the uranium-ore.

As to the origin of the last-named, it appears to have been deposited from aqueous solutions charged with carbon dioxide, and the circumstance that, of all the ores of the district, it occurs the deepest down, points to its deep-seated genesis. If the outcrops of uranium-ore be plotted out on a map, it will be found that their connection with the previously mentioned granitic intrusion of the Western Erzgebirge is startlingly apparent.

L. L. B.

THE CHROME-IRON-ORE DEPOSITS OF DUBOSTICA, BOSNIA.

Das Nebengestein der Chromeisenerzlagerstätten bei Dubostica in Bosnien, und das Auftreten von sekundärgebildetem Chromit in demselben. By Bruno Baumgärtel. *Tschermak's Mineralogische und Petrographische Mittheilungen*, 1904, *new series*, *vol. xxiii.*, *pages* 395-400, *and* 1 *plate*.

The chrome-iron-ores of Dubostica, north of Vareš in Bosnia, are, as in so many other localities, associated with serpentines. These rocks, together with gabbros, diabases, and the corresponding tuffs, help to build up the range of hills which trends north-westward from Kladanj to Banjaluka, over a length of 82 miles. They date from a time certainly anterior to the Cretaceous, and are thought to be of Jurassic age, if not older.

The author worked at a collection of rock- and ore-specimens sent to the Royal Mining Academy at Clausthal from the Dubostica mines. He found the chief minerals therein, in order of abundance, to be:—Chromite, rhombic and monoclinic pyroxene, olivine, serpentine in various stages of formation, bastite, and chrome-spinel. The chromite alone exhibits occasionally a regular crystalline form, occurring then as well-defined octahedra in perfectly-fresh pyroxene. This would prove that the chromite was separated out from the magma before the pyroxenes began to solidify. In other specimens, the chromite is in the form of isolated crystalline grains, which finally increase in number so much as to form the sole constituent of the rock. The monoclinic pyroxene, distinguished from the rhombic by its higher

double-refraction, has a fine green coloration—a sign, to some extent, that chromium is included among its constituents; in fact, it turns out to be a chromium-diopside. This pyroxene, in course of serpentinization, gives rise to the formation of chromite, which in such cases is a secondary or decomposition-product, as distinguished from the primary chromite described above.

The conclusion to be drawn is that both the newer theory that chromite is a mineral of primary origin, and the older, that it is one of secondary origin, are in accordance with the facts. The rock in which the chromite occurs in these Bosnian deposits is defined as a lherzolite, and the ore appears to be there predominantly of primary origin. L. L. B.

JÁNOSITE: A NEW MINERAL FROM HUNGARY.

Über ein neues, wasserhaltiges, normales Ferrisulfat, den Jánosit. *By* Dr. Hugo Böckh *and* Dr. Koloman Emszt. *Földtani Közlöny*, 1905, *vol. xxxv., pages* 139-142, *with* 1 *figure in the text.*

The graphitic slates interbedded among the iron-ore deposits of Vashegy, in county Gömör, are characterized by an abundant efflorescence of sulphates, derived from the decomposition of the sulphide of iron contained in the slates. Among these sulphates is a greenish-yellow, pulverulent mineral which occurs in the main cross-cut of the first level of No. 1 shaft of the mine. Under the microscope it is seen to be made up entirely of minute tabular crystals belonging to the rhombic system, with excellent cleavage. As the mineral scratches selenite, but not calcite, its hardness ranges between 2 and 2·5. Its specific gravity is a little over 2·5; it is soluble in water, and the solution tastes of vitriol. It loses some of its water of crystallization at a temperature of 212° Fahr., and the whole of it at 482°. Quantitative analysis shows that it is a hydrated ferric sulphate, corresponding to the formula, $Fe_2 3(SO_4)9H_2O$, with mere traces of alumina. Chemically, it is almost identical with coquimbite, and approximates to quenstedtite, but it is widely different from these in crystalline form, specific gravity, coloration, etc. Consequently, the authors regard it as a new mineral-species, and they named it Jánosite, in honour of Councillor János Böckh, Director of the Royal Hungarian Geological Institute. L. L. B.

ORE-DEPOSITS OF CROATIA.

Das Erzrevier von Beślinac-Trgove in Croatien. *By* J. Hörhager. *Österreichische Zeitschrift für Berg- und Hüttenwesen*, 1903, *vol. li., pages* 87-90, *and* 104-108, *with* 1 *illustration in the text.*

At Ljubia in Bosnia, the cone of the Adamusa mountain consists of brown ironstone, 200 feet thick, containing 60 per cent. of iron. It is not worked owing to the lack of railway-communication, but thousands of tons of slag at the foot of the mountain show that iron-mining and smelting was formerly a great industry here.

In the Croatian district of Beslinac-Trgove, silver-bearing galena was worked before the occupation of the country by the Turks, and again about 1870. Copper-pyrites was also worked; and at the beginning of last century an iron-furnace, forge and a foundry were started, wood-fuel from the surrounding forests being used. As the iron was smelted with charcoal and cold-air blast, it was of excellent quality, but the works were 30 miles from the railway, and the road infested by brigands.

The Trgove shale, in which the ore-beds occur, belongs to the Alpine coal-formation, as shown by its fossils. It stretches for about 12 miles in a north-westerly direction until cut off by the Cretaceous formation. The ore-bearing rock rises 650 to 1,000 feet above the Zirovac valley, and consists chiefly of shale, with a dip north-westward and south-westward. To the south-eastward, the strata lie horizontally, then rise at an angle of 40 to 50 degrees, and towards the north-west are almost vertical. Silver-bearing galena is found in the lodes at the surface, copper-pyrites lower down, and iron-ore in the lowest parts. The shale extends to a little stream, beyond which Trias appears, with dolomite, chalk, greenstone, serpentine and sandstone, and above it, in the Tertiary, are beds of fire-clay. A coal-seam, 6 feet thick, crops out at the surface.

Since the Carboniferous period, the horizontal shales were subjected to eruptive forces; and clefts and fissures were formed, in which lead-, copper- and iron-ores were deposited, partly by hot mineral solutions from below, and partly by infiltration from above. The strata are impregnated with quartz, which could only be dissolved in hot water under pressure, and separated as the temperature and pressure fell; and sulphuretted hydrogen vapours arose from the interior of the earth. E. M. D.

ALUMINIUM-ORES OF THE BIHAR MOUNTAINS, HUNGARY.

Die Aluminiumerze des Bihargebirges. *By* Dr. Julius von Szádeczky. *Földtani Közlöny*, 1905, *vol. xxxv. pages* 247-267, *with a map in the text.*

Dealing first with the deposits situated in the northern portion of the area, in the neighbourhood of Remecz, the author states that the aluminium-ores occur all round the eruptive dacite-massif of Mount Bóti; this forms roughly an ellipse, with its major axis trending east and west. On the eastern extremity, in continuation of this axis, abuts the Mesozoic limestone-massif of the Fruntye, on the dip-slope of which are found the most important ore-bodies (four in number) of the neighbourhood; south-eastward, the Fruntye forms a steep escarpment walling in the Jád valley. The other aluminium-ore deposits, around Mount Bóti, are not seen in direct contact with the outcropping dacite, but occur very near it, with a general east-and-west strike. The ore is tough, reddish-brown in colour, and appears to be in all cases interbedded among the limestones. The total amount of ore in sight in the northern portion of the area is provisionally estimated at 5,000,000 cubic feet.

The deposits in the southern portion of the area occur in belts trending from south-east to north-west, which at their north-western extremity curve round the plagioclase-granite bosses of the Száraz valley. Just as in the northern area, and especially in the western portion, the aluminium-ores are seen to pass into iron-ores. Eleven different exposures are described, and the author then enters into details in regard to the Bihar aluminium-ores as a whole. From the point of view of coloration, three categories are distinguishable: (1) the dark reddish-brown; (2) the pale-yellow, pale-red or grey; and (3) the dark greyish-brown or black. The first-named variety predominates, but in almost every deposit the second variety occurs in association with it, while the third is of far rarer occurrence. Concretionary nodules of magnetite are frequently found in the dark-red deposits; and the dark-brown or black deposits are strongly magnetic, on account of the enorm-

ous quantity of granular magnetite which they contain: indeed, the latter may be regarded as the intermediate link between the other aluminium-ores and the magnetite-beds into which they pass. The paler ores probably owe their light coloration to the diminished proportion of ferruginous constituents which they contain: they are consequently richer in aluminium than the other two varieties. They seem generally to constitute the fringe or marginal portion of the deposit in which they occur, and often contain a quantity of impure silicates. On weathering, the originally compact ores crumble into pulverulent masses; and it is hardly necessary to add that such decomposition-products as limonite and malachite are associated with them. Seven chemical analyses are tabulated, and they show that the percentage of alumina in the ores ranges (roughly) from 50 to 76, and that of iron peroxide from 14 to 31. The mean of several specific-gravity determinations is 3·329. Naturally, the heaviest ore is the dark variety which contains the highest proportion of magnetite. From a consideration of the specific gravities of the associated minerals, the author concludes that it will be easy to separate mechanically the heavier ferruginous constituents from the lighter aluminium-minerals, and this may prove to be of industrial importance.

A discussion of the tectonic structure of the rocks among which the deposits occur leads to the inference that these are of hydrothermal origin. The hypothesis is strengthened by the occurrence of thermal springs along the strike of the ore-belts, and by the pisolitic, concretionary texture of the ores themselves. Their age must remain, for the present, an open question; all that can be said is that they are certainly not older than Upper Cretaceous, and are possibly much younger.

In conclusion, the author points out that, although the chemical composition of one variety of the Bihar ores assimilates it to bauxite, yet the ores on the whole must be regarded as made up of various minerals. Now, these ores, when contrasted with the majority of the bauxites, are in a comparatively fresh, unweathered condition; and, if it were shown, on closer investigation, that the bauxites are really a congeries of various minerals, in which, perchance, the formation of decomposition-products is farther advanced than in the Bihar ores, the name "bauxite" could no longer be regarded as properly defining a single mineral, but as defining a rock-species. L. L. B.

KAZANESD PYRITES-MINES, HUNGARY.

Die Schwefelkiesgrube in Kazanesd, Komitat Hunyad. By ANTON LACKNER. *Földtani Közlöny*, 1904, *vol. xxxiv., pages* 469-488, *with* 5 *figures in the text and* 1 *plate.*

The hills of the immediate neighbourhood of Kazanesd consist chiefly of dark-green diabase, wherein inclusions or "eyes" (as the author terms them) of pyrites are of constant occurrence. Narrow veins of a compact pink porphyry seam the diabases and the ore-deposits; and near the eastern extremity of the chief ore-body occur, some 13 feet apart from each other, two porphyry-dykes, whereof one is 10 feet and the other 6½ feet thick: these are cupriferous at the contact with the pyrites. To the south-east, at the entrance of the Ponor valley, is a trachytiform rock defined as "grano-diorite," which has proved to be a good building-stone. With regard to the chronological succession of all these rocks, the available evidence appears to show that the diabase is the oldest, next comes the grano-diorite, then the pyrites, and finally the quartz-porphyry.

The ore-body extends in a south-westerly direction for about 260 feet, varying in breadth from 50 to 65 feet, and has been proved in depth to at least 130 feet; it occurs at an altitude of 1,100 feet above sea-level. The deposit is compared by the author with similar occurrences in Norway and Canada, and he regards it as the probable outcome of magmatic differentiation. That is, it might well belong to Prof. R. Beck's group of "syngenetic ore-deposits," which are of contemporaneous origin with the country-rock (in this case, the diabase).

In composition, the Kazanesd ore approaches the theoretical proportions of 46·67 per cent. of iron and 53·33 of sulphur, with small quantities of copper or nickel; but in the easternmost outcrop, the so-called "Kupferstock," marcasite, chalcopyrite, bornite, malachite and azurite are associated with the pyrites, in the form of little veins rather less than an inch thick, or of impregnations. The percentage of copper in this portion of the deposit ranges from 1 to 16. The total amount of ore in sight is estimated at little short of 1,500,000 cubic feet. Systematic working is at present conducted only by one company; the workings are no longer opencast, as they were overwhelmed by landslips of weathered rock, and the ores are mined by means of shafts sunk to a moderate depth (100 feet or so). When the baskets of ore have been wound up to the surface, their contents are machine-sorted into five or six categories, according to size, ranging from "flour" to "large" [lumps]. The cupriferous pyrite is first of all sorted below bank, and is machine-sifted above bank, that which passes through the meshes of the sieve being termed "copper-flour"; the remainder, in lumps about as big as a man's fist, is sorted out by mere inspection into five different grades. More recently, however, the practice has grown up of recognizing only three grades, the first containing from 10 to 14 per cent. of copper, the second from 4 to 6, and the third from 1 to 2.

A narrow-gauge railway connects the mine with the railway-station of Alvácza, about 8 miles distant.

The mine is drained by a Garvens pump, all the portions of which likely to come into contact with the corrosive mine-waters consist of gun-metal, and the suction-pipes, etc., are of lead; the pump is worked by a 3 horse-power Bánky-Csonka benzine-motor, and raises 35·2 gallons of water per minute. Labour is mainly provided by Rumanians, who earn from about 11d. to 1s. 2d. as day-labourers, but miners on piecework make from 1s. 6d. to 2s. 3d. a shift. The output in 1904 averaged 15,000 quintals (say 736 tons) a month. L. L. B.

IRON-ORE DEPOSITS OF THE ROZSNYÓ DISTRICT, HUNGARY.

Die geologischen Verhältnisse auf dem Gebiete zwischen Nagy-Veszverés, der Stadt Rozsnyó und Rekenyefalu. By ALEXANDER GESELL. *Jahresbericht der Königlichen Ungarischen Geologischen Anstalt für 1903, pages* 170-178.

A good half of this Survey-memoir is devoted to the history of the metal-mining industry of the district, which dates many centuries back; the main square of the old town of Rozsnyó itself, indeed, occupies the site of mediæval waste-heaps.

The principal objects of mining operations in this region have always been the numerous "dykes" or "beds" of spathose iron-ore intercalated among the porphyroids and porphyroid slates, which, together with metamorphosed slates, sandstones and breccias, constitute the predominant rocks.

These ores belong to one of the three ore-belts which go to make up the "Sajó" group of Dr. Livius Maderspach. This particular belt is characterized by the great development of the porphyroids and porphyroid slates, with spathose iron-ores and quicksilver-ores. The two other belts, of less superficial extent, are also characterized by the occurrence of iron-ores, but in one of them brown hæmatites are found among the compact porphyroid slates, and moreover the actual alteration of spathose iron-ore into brown hæmatite at the outcrops has been noted.

In the Szölömár and Rákos (Magastetö) areas the iron-ore deposits may be described as bedded veins, and invariably strike parallel with the bedding of the rocks. The ore-body is always sharply marked off from the country-rock, which itself weathers with extreme rapidity at the surface. Quartz is a constant associate of the ore, which is coarse-grained and pale in colour. Of less frequent occurrence are druses encrusted with fine pale-yellow crystals of the same. Among other associated minerals are heavy-spar, chalcopyrite and pyrites. The veins are of diverse thickness, among the most important being the Bodnarka and István reefs worked in the Government mine at Nadabula.

The Government mines of Rudna have restarted work since 1898, and there three reefs of spathose iron-ore have been proved, of a total thickness of about 15 feet.

At Csucsom, another State mine works a vein infilled with quartz and spathic manganese-ore (diallogite), with which are associated chalcopyrite and pyrites.

In November, 1900, the Rimamurány-Salgótarjá Iron-works Company began to drive a deep-level adit at Rozsnyó, which is now about 5,000 feet long, and has already cut one metalliferous vein at three points. It is reckoned that about 1,000 feet more will have to be driven to cut another well-known vein. L. L. B.

MANGANESE-IRON-ORE DEPOSITS OF MACSKAMEZÖ, HUNGARY.

Das Mangan-Eisenerzlager von Macskamezö in Ungarn. *By* DR. FRANZ KOSSMAT *and* C. VON JOHN. *Zeitschrift für praktische Geologie*, 1905, *vol. xiii., pages* 305-325, *with* 4 *figures in the text.*

On the banks of the Lápos river, west of Magyar Lápos in the county of Szolnok-Doboka, the crystalline-massif of the Preluka rises from amidst the generally horizontally-bedded sediments of Paleogene and Neogene age: in the eastern portion of this massif lies the ore-deposit of Macskamezö. After many vicissitudes it has at last passed into the possession of Count Julius Esterhazy, and, worked at one time for its hæmatites, etc., is now being worked exclusively for its manganiferous ores.

The Preluka massif consists essentially of garnetiferous mica-schists, occasionally passing into gneiss; intercalated among them are chlorite- and hornblende-schists, as also bands of dolomitic marble. Pegmatite-veins in a few places traverse the crystallines. The eastern portion is shown to be, structurally, an anticline striking north-eastward. The various outcrops of ore, always traceable below a certain conspicuous band of marble, are described in detail; and a sharp distinction is drawn between the crystalline ore-body and the (secondary) products of alteration, the former consisting chiefly of manganese and iron-bearing silicates. There is generally a distinct bedding of the ore-body, more plainly to be seen where bands of silicate

alternate with layers of magnetite or of carbonate of manganese. The occasional presence of barytes-crystals in the ore suggests that traces of barium must have occurred in the original matrix. The oxidic ores vary in character: besides the generally predominant, often very rich pyrolusite, psilomelane and manganite are met with, as in other deposits of this nature.

The highly oxidized outcrop or upper portion of the deposit must have been subject to the influence of atmospheric agencies before the commencement of Tertiary time, as the sandy and conglomeratic basement-beds of the Eocene overlie it horizontally. Moreover, the secondarily formed ore-body has been evidently subjected to tangential movements which would appear to have been contemporaneous with the folding of the Tertiary strata. The primary or crystalline ore-body is a typical product of regional metamorphism, evolved from what was originally a sedimentary deposit. It is comparable with the metamorphic iron-ores of Northern Norway which are regarded by Prof. J. H. L. Vogt as having been in the first instance chemically precipitated on the sea-bottom. Examples of such chemical sedimentation alike in sea-waters and in lake-waters are pretty well known in our own day. The ore-deposits of Eisnern in Carniola and of Jakobeny in the Bukovina are also compared with the Macskamezö deposit.

A detailed description is given of the mineralogical constitution and chemical composition of the silicate ore-body, illustrated by a great number of analyses. The predominant mineral is knebelite (manganese-iron-olivine) with somewhat less dannemorite (manganese-hornblende); with these apatite is associated, in locally varying quantity. Analyses are also given of the pyrolusites and other oxidic ores, and of the carbonates of manganese. A specimen of the highly magnetic ore, worked opencast at the Frintura mine, yielded 40·16 per cent. of manganese and 32·01 per cent. of iron.

L. L. B.

PETROLEUM-DEPOSITS ON THE BORDERS OF MORAVIA AND HUNGARY.

Petroleumvorkommen im mährisch-ungarischen Grenzgebirge. *By* A. Rzehak. *Zeitschrift für praktische Geologie*, 1905, *vol. xiii., pages* 5-12.

The reported presence of traces of petroleum in springs in the neighbourhood of Bohuslawitz, where the Wlara river cuts a gorge through the mountains that form the boundary between Moravia and Hungary, induced the Austrian Government to entrust the author with a commission to carry out a detailed geological survey of the district. The predominant strata are slaty marls and calcareous, somewhat argillaceous sandstones; subsidiary to these are pale, indistinctly-bedded sandstones, poor in lime, and those red, occasionally green-flecked clays which play so important a part in the Galician oil-region. In fact, many of the varieties of rock in the Bohuslawitz area are comparable with well-known rock-types of Galicia. Palæontological evidence shows that the beds are of Eocene age, and certain of the foraminifera are identical with those found in the petroleum-bearing beds of the Galician Carpathians. The strike is, on the whole, parallel with the trend of the mountain-ranges, that is, east-north-easterly and west-south-westerly. Instances of individual exceptions to this general strike are, however, cited. The dip is steep, usually 60 to 70 degrees, and sometimes as much as 85 degrees. It would seem that the normal anticlines observable in the district have, in the immediate neighbourhood of Bohuslawitz, been upthrust, and, in part, overthrust.

No. 1 bore-hole, begun in the summer of 1899, was stopped at the depth of 1,480 feet, without having struck any deposit of industrial importance. No. 2 bore-hole, begun in December, 1900, was stopped in March, 1902, at the depth of 2,116 feet. The author had advised that the undertaking be started to the dip of the previous boring; but his advice was overruled by "practical men," and operations were conducted to the rise of No. 1 bore-hole. Inflows of water were disagreeably frequent, and it may be remarked by the way that the thickness of the water-bearing sandstone in the Galician oil-region is nothing like so considerable as it is in the district here described. Natural gas came off at times in great quantity, and a certain amount of a light reddish-brown transparent oil was got, showing a vivid green fluorescence, and possessing a specific gravity of 0·8744. The oil, on analysis, proved to be a very exceptional variety of petroleum: it contains barely a trace of paraffin, and no benzine.

In May, 1902, No. 3 bore-hole was started, about 150 feet south-west of No. 1 bore-hole, but was abandoned at the depth of 640 feet, and therewith all hopes of finding a really rich oil-reservoir were given up.

In view of the fact that, until the very last, experts acquainted with the practical details of "petroleum-geology" had regarded the surrounding conditions as highly favourable, the author discusses at some length the probable causes of failure, and gives the following summary of his conclusions:—(1) The stratigraphical conditions in the neighbourhood of Bohuslawitz do not favour the accumulation of petroleum in great natural reservoirs, nor do they favour the working of such strata as may bear oil. (2) The absence of the slightest traces of naphtha along the Wlara river, or in the numerous deep-cut watercourses of the district, forbid the idea of the existence of any extensive petroleum-deposits there. (3) The productive naphtha-deposits of the Carpathians thin out in Western Galicia, and Moravia lies evidently outside the true Carpathian petroleum-area. Such occurrences of oil as may be recorded west of the Beskides are to be regarded as purely local and of limited extent. The resemblance of the Bohuslawitz rocks and their fossil contents with those of Galicia does not affect these conclusions in the least. The author had always been sceptical as to the prospects of boring for oil in the district described, and he had already (in 1899 and 1900) put before those chiefly concerned the conclusions tabulated above.

L. L. B.

COPPER-ORE DEPOSITS OF RADMER AN DER HASEL, STYRIA.

Der Kupferbergbau Radmer an der Hasel, die Fortsetzung des steirischen Erzberges (Steiermark). *By* DR. KARL A. REDLICH. *Berg- und Hüttenmännisches Jahrbuch der k. k. montanistischen Hochschulen zu Leoben und Pfibram*, 1905, *vol. liii., pages* 1-38, *with* 2 *figures in the text and* 1 *plate.*

These deposits were at one time renowned as the richest of the kind in Styria, and mining operations are said to have been started on them as far back as the year 1547; at all events, the author is able to give, by way of appendix, very nearly continuous statistics of the annual output from 1567 down to 1842 inclusive. The workings were abandoned in the year 1855; but in 1900 prospecting work was resumed, with the result (so far) that only one great lenticle of copper-pyrites has been struck. This has yielded 100 tons of ore containing, on an average, 16·5 per cent. of metallic copper.

The first chapter of this memoir is purely historical; the second deals

with the topography and geology of the district, and we learn that the latter is extremely complicated. The northern portion of the Radmer valley consists of Werfen slates with bands of gypsum and brine-springs, capped by precipitous crags of limestone and dolomite, all belonging to the Trias. The southern portion consists of presumably Siluro-Devonian grauwackés, black and grey slates, and great masses of conspicuously-banded black, white and grey limestones. The dip of these is steep, 60 to 70 degrees north-north-eastward, and they overlie unconformably the other Palæozoic rocks. It was after the deposition of these limestones that the ore-deposits were formed, the chief constituents of which are (1) ankerite enveloping lenticular masses of siderite (with 39 per cent. of metallic iron), both being altered by atmospheric agencies into limonite; and (2) copper-pyrites. The latter occurs dispersedly in nests among the carbonate of iron, and analyses carried out in 1903 show it to contain from 23 to 32 per cent. of copper, 16 to 29 per cent. of sulphur, 27 to 31 per cent. of iron, 14 parts per million of silver, and traces of gold. In association with these ores, but in much smaller quantity, there occur tetrahedrite, cinnabar, iron-pyrites and arsenical pyrites, with a quartzitic and calcitic gangue. The results of decomposition nearer the surface have produced such minerals as cuprite, malachite, azurite, aragonite, and some native copper.

The author adduces in detail evidence to show that solutions containing metalliferous particles made their way through fissures in the grauwacké slates (there giving rise to mineral-veins), and when they reached the overlying limestones they easily decomposed these, the result of the chemical interactions being the deposition, by metasomatic replacement of the limestones, of "metamorphic beds of ore." He further dwells on the resemblance of the Radmer deposits with those of Eisenerz, in the Styrian Erzberg.

The only hope of finding untouched deposits that would repay working on a large scale lies in carrying on the search at greater depths than has hitherto been done. It would be necessary to sink a shaft at least 500 feet deep, and make several cross-cuts. As considerable inflows of water (judging from past experience) would have to be reckoned with, it would also be necessary to erect appropriate pumping-machinery. L. L. B.

COPPER-ORES IN THE VEITSCH VALLEY, STYRIA.

Die Kupferschürfe des Herrn Heraeus in der Veitsch. *By* DR. KARL A. REDLICH. *Österreichische Zeitschrift für Berg- und Hüttenwesen*, **1903**, *vol. li., pages* 449-450, *with* 1 *illustration in the text.*

In a fork of the Veitsch valley are the remains of workings dating from the eighteenth century. They were started by Mr. Heraeus, a Swede, who began mining for copper in 1719, but lost his own fortune, and that of others, in the venture. After his death the works passed through various hands, and a furnace was set up, but little copper was produced.

A lode of quartz, 5 feet thick, containing copper pyrites and tennantite (grey copper) occurs in Carboniferous strata, but there is not enough ore to make it profitable to work. At first sight, it appears to be a natural bed, but closer inspection shows that limestone has been replaced by the quartz and pyrites, and that it is a metamorphosed bed. A little higher up the valley, the ore also occurs in a bed of black schist of Palæozoic age.

E. M. D.

MAGNETIC PYRITES OF KNITTELFELD, STYRIA.

Ein Magnetkiesvorkommen in der Lobming bei Knittelfeld. By VIKTOR ZELENY. *Tschermak's Mineralogische und Petrographische Mittheilungen*, 1904, *new series, vol. xxiii., pages* 413-414.

Among the muscovite-orthoclase gneisses which occur near the village of Klein-Lobming, south of Knittelfeld, there is a vein parallel with the bedding-planes, striking eastward, and dipping at an angle of 30 degrees westward, which is chiefly made up of magnetic pyrites. Chemical analysis shows the ore to contain 61·5 per cent. of metallic iron, 37·2 per cent. of sulphur, 0·39 per cent. of nickel, and a trace of copper. With it are associated zinc-blende, pyrites, and a basic andesine (felspar). The actual vein is only a few inches thick, but the zone of ore-impregnation extends into the country-rock for several feet on each side. This occurrence probably belongs to the same complex of veins as the copper-pyrites of the Flatschach (9 miles away to the north, as the crow flies) and the arsenical pyrites of the Feistritzgraben.

About 10 miles to the west, another occurrence of magnetic pyrites is reported, in the commune of Oswaldgraben, district of Voitsberg. Here it is found, intimately intergrown with brown tourmaline and associated with copper-pyrites, in garnet-mica-schists. L. L. B.

ORE-DEPOSITS OF RABENSTEIN, TYROL.

Das Erz- und Fluss-spatvorkommen am Rabenstein im Sarnthal (Südtirol). By M. KRAHMANN. *Zeitschrift für praktische Geologie*, 1906, *vol. xiv., pages* 8-10, *with a plan and section in the text.*

This is a preliminary notice of a deposit which the author had occasion to investigate recently in the Upper Sarn valley, which debouches at Botzen in Southern Tyrol. This upper portion of the valley, known as the Penserthal, is up stream from Sarnthein carved out of quartz-phyllites and mica-schists, and from Aberstikl onwards trends almost exactly parallel with the north-eastern strike of the beds. Crags of gneiss and granite wall in the valley, and a few diabase-dykes traverse the quartz-phyllite in a direction which makes an acute angle with the strike. At the Rabenstein, some 9 miles up stream from Sarnthein and 21 miles above Botzen, in the neighbourhood of these intrusive dykes, occur several distinctly dyke-like deposits of fluorspar, with which along certain bands are associated masses of galena and blende. Two such metalliferous reefs have been the object of close investigation: (1) the main or Rosa reef, which is traceable for some distance in depth, and (2) about 500 feet above it, the hanging-wall reef or vein, which has only been traced in the upper levels.

Not only from the standpoint of its mode of origin, but from the industrial standpoint also (in view of its possible extension) is the tectonic position of this occurrence interesting. It coincides precisely with the great Judicarian line of faulting and fracturing. At the deepest level yet reached in the workings (about 100 feet below the hillside adit, called the Rosa adit), the main reef is 8¼ feet thick, and shows an enrichment in blende. Mr. F. Teller has already pointed out,* that the extraordinary parallelism, between the diabase-porphyrite dykes and the metalliferous reefs on the one hand, and the great Judicarian fault-line (along the south-

* "Ueber ein neues Vorkommen von Diabas-porphyrit bei Rabenstein im Sarnthale, Tirol," *Verhandlungen der k. k. geologischen Reichsanstalt*, 1887, page 198.

eastern margin of the ancient granite-massif) on the other, is more than a mere coincidence. The investigator is irresistibly led to the conclusion that both the dykes and the reefs represent a secondary system of fissures opened up in the phyllite-complex, in consequence of the deep-seated fracturing along the margin of the granite. This conclusion is confirmed in the map recently published by Mr. P. Termier.* Meanwhile work is proceeding, with the view of exploring these ore-deposits more completely. L. L. B.

STRATIGRAPHY OF THE LIÉGE COAL-BASIN, BELGIUM.

Stratigraphie du Bassin Houiller de Liége. By X. STAINIER. *Mémoires de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 1905, *vol. xix., pages* 3-120, *and* 1 *plate.*

In this memoir, the author's elaborate investigations are restricted to the left bank of the Meuse. In the course of six chapters, he deals with 117 distinct horizons, but shows once again that the number of coal-seams postulated by the older writers must be considerably diminished, so as to accord with the ascertained facts. Broadly speaking, for every 100 feet of Coal-measures in the Liége coal-field, there are 20 feet of grits and 80 feet of shales; about forty seams are generally workable, and ten seams occasionally or accidentally workable, the total number of workable seams amounting, therefore, to fifty. There seems to be within the basin what Prof. Stainier terms a " nodal " region, where the seams are packed closer together and are richer in coal. Radiating from this " nodal " region, the thick seams subdivide, and string out into thinner seams which diverge more and more one from the other as they recede from the " nodal area." Although the precise limits of this region are undefinable, and it seems to oscillate in the course of the Coal-measure period, such variations as occur are generally symmetrical to the east and the west of it. At all events, nowadays, the " nodal area " constitutes the central and thickest portion of the basin; and there is reason to believe that here actually lay the deepest waters, wherein slow and tranquil sedimentation took place. The existence, at different times within the Coal-measure period, of secondary basins, in which special biological and sedimentary conditions were prevalent, is inferred from the fact that at one locality a whole succession of strata will be found to exhibit certain lithological characters in common, while the same succession at another locality will exhibit a different set of lithological characters.

On following up any given portion of the Coal-measures included between two known horizons from place to place, it is found that the interval between these horizons occasionally fluctuates considerably and it is noteworthy, in the Liége coal-basin as elsewhere, that any general increase in thickness coincides with a marked thickening of the interstratified grits. In some cases, this increase takes place regularly from west to east.

The distribution of the grits within the Liége Coal-measures is very irregular. There are remarkably few bands of grit in the St. Gilles division, for instance. On the other hand, limestone-horizons, the first of which was discovered barely three years ago, are found to recur pretty frequently.

In abundance of fossils the Liége coal-field is now found to surpass that of Charleroi; at some horizons, indeed, the number of individual specimens can only be termed prodigious, and they are generally in a better state of

* " Les Alpes entre le Brenner et la Valteline," *Bulletin de la Société géologique de France*, 1905, vol. v., page 209.

preservation than the Charleroi fossils. *Carbonicola* (*Anthracosia*)-bands, are, moreover, much more numerous in the Liége basin than in that of Charleroi. On the other hand, fish-remains and marine faunas generally are much scarcer on the left bank of the Meuse than at Charleroi. The supposed scarcity of marine fossils in the one coal-field may, however, be due to the fact that the strata which presumably contain them are less accessible and less easily worked than in the other coal-field. The author describes in detail the sixty-six fossiliferous horizons which he has recognized in the area dealt with, and notes that they are distributed fairly evenly throughout the Coal-measures: three unfossiliferous zones may, however, be noted, one of them occurring in the very topmost Coal-measures.

The writer discusses the transformations of the fauna, and closing therewith the second section of the memoir, he proceeds in the third section to set forth the chemical composition of the coal-seams. Broadly speaking, the youngest or latest deposited seams are, as elsewhere, richest in volatile matter, but there are very notable individual exceptions. Any given seam of coal, other things being equal, varies in composition according to the portion of the coal-field in which it is examined. Also, following a direction transverse to the main axis of the basin, the same seams will be found to become more highly bituminous in proportion as they approach the southern rim. On either side of the great longitudinal faults, which cut through the basin, the seams exhibit considerable differences. Thus, for instance, the seams on the south side of the St. Gilles fault frequently contain 5 per cent. more volatile matter than they do on the north side. Supposing that a seam be followed up roughly from north to south (along a straight line transverse to the main axis of the basin), it is found that every time that a fault is crossed, the seam becomes more highly bituminous, which perhaps will explain the statement (made above) as to increase in bituminosity concurrently with approximation to the southern rim.

The fourth and fifth sections of the memoir are devoted to questions of correlation. There are remarkable analogies between the Liége and Charleroi coal-fields. In regard to the proportion of coal present in the entire thickness of the Namurian and Westphalian series, the concordance is absolute for the Assises de Charleroi, de Châtelet, and d'Andenne. The Middle Coal-measures are thicker at Liége than at Charleroi, while the converse holds good of the Lower Coal-measures. The number of workable seams is greater at Liége, but the thickness of the individual seams is slightly greater at Charleroi. Proportionately, there are more grit-bands in the Charleroi Coal-measures than in those of Liége.

No. 41 marine band in the Liége coal-field appears to correspond in some respects with the highest marine bands found in Westphalia and in Lancashire, but the Liége marine band is probably much nearer the base of the Coal-measures than the other two, and there are faunal differences which also weaken the case for synchronism. L. L. B.

CHROMIUM AND VANADIUM IN THE LIÉGE COAL-MEASURES, BELGIUM.

Sur la Présence du Chrome et du Vanadium dans le Terrain Houiller de Liége. By A. JORISSEN. *Académie Royale de Belgique, Bulletin de la Classe des Sciences*, 1905, *pages* 178-181.

The author has been engaged for several years in demonstrating the presence of comparatively rare elements in the rocks of Belgium. Thus, in 1896, he showed that molybdenum, bismuth and selenium were to be

found in the Liége Coal-measures, the two first-named being new to Belgium. The material from which he extracts his rare elements is the soot derived from the combustion of coal brought from La Haye colliery, at Liége; but he has also examined specimens of soot and coal-dust obtained from factories, etc., burning coal from other collieries in the Liége basin, and finds that, in regard to the presence of rare elements, they are very analogous to the La Haye soot.

To his former lists (1903, etc.) including, besides the three above-mentioned elements, compounds of arsenic, antimony, copper, lead, thallium, nickel, cobalt, zinc, titanium and barium, he is now enabled to add chromium and vanadium. These two elements are obtainable not only from the soot, but by appropriate treatment from Coal-measure shale also. This treatment, involving apparently a good deal of laboratory-work, is described in detail. L. L. B.

THE NEW COAL-FIELD IN FRENCH LORRAINE.

(1) *Sur la Découverte de la Houille en Meurthe-et-Moselle.* *By* C. CAVALLIER. *Comptes-rendus hebdomadaires des Séances de l'Academie des Sciences*, 1905, *vol. cxl. pages* 893-895.

The search for the western prolongation of the Saarbrücken coal-field, abandoned in 1895, was resumed in 1899, in consequence of the rise in the price of coal. By the end of 1900, the search had already proved successful on the German side of the frontier; and various French metallurgical syndicates, having watched carefully the progress of the search, thereupon sought the advice of geological experts as to what localities in the department of Meurthe-et-Moselle were the most likely spots for boring operations. Their advice was followed, and the boring at Pont-à-Mousson showed an unhoped-for thinning-out of the barren measures which intervene between the top of the Bunter grits and the top of the Coal-measures. The last-named occur some 300 feet nearer the surface at Éply, as also at Hémilly 20 miles distant from the Éply boring (in following the trend of the anticline). The author discusses, but prudently leaves open, the question of the probable extent of the Meurthe-et-Moselle coal-basin. As to its mineral wealth, the available evidence is as yet scanty, but the No. 3 boring at Faulquemont (comparatively close to the German frontier), in passing through 546 feet of Coal-measures, struck seven seams, the united thickness of which amounts to 47 feet.

(2) *Exploration du Terrain houiller en Lorraine française.* *By* C. CAVALLIER. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 1905, *vol. xix., Mémoires, pages* 483-497, *with* 3 *figures in the text and* 1 *plate.*

In reviewing the results achieved by the borings put down within the last three years on the French side of the frontier, the author points out that all that they show so far is that the Coal-measures are reached at an accessible depth. They do not yet show whether these measures are likely to prove sufficiently productive from the industrial point of view. The Éply, Atton, Pont-à-Mousson and Lesménils borings, when compared, prove that the roof of the Coal-measures dips steeply north-westward; and the underground contours mapped from them enable one to trace the position of the crest of the great anticline originally postulated by Mr. R. Nicklès. That observer had indeed pointed out that the summits of anticlines are geometrically the most favourable positions for trial-borings; and thus in

the borings put down on the anticline a minimum thickness of barren strata was recorded, while the thickness of these was shown to increase progressively northward and southward, at Lesménils and Laborde.

The first boring to strike workable coal, 2·3 feet thick, at a depth of 2,686 feet and 2,092 feet below sea-level (46 feet below the roof of the Coal-measures) at Pont-à-Mousson on March 19th, 1905, has since been carried 1,840 feet or more deeper down, and has proved four more coal-seams, respectively 2 feet, 16 inches, 4 feet and 2 feet thick.

On May 5th, 1905, in the Atton boring, a coal-seam 22 inches thick was struck at the depth of 2,601 feet from the surface; and on June 26th, in the Abaucourt boring, a seam 8¾ feet thick was struck at the depth of 2,940 feet. The coal from this seam contains 39½ per cent. of volatile matter, and yields 3½ per cent. of ash. At Laborde, so far only one seam, 12 inches thick, has been struck, at a depth of 3,264 feet. On the whole, it may be affirmed that there are in the department of Meurthe-et-Moselle two distinct coal-belts, both of them accessible and both of them productive: the Éply-Pont-à-Mousson belt, wherein the measures belong to the Westphalian division; and the Abaucourt-Laborde belt, wherein they belong to the Stephanian division. Between the two there is some stratigraphical disturbance, the nature and exact position of which are as yet unknown.

The Coal-measures have been reached at many points nearer the surface than was expected, on account of the westward thinning of the Triassic Bunter grits (Grès des Vosges, etc.). The author holds that, even if the boring operations now in process were to prove disappointing, further borings should be put down, on account of the immense importance, from the French point of view, that attaches to the possible opening-up of a new coal-field in France.

(3) *Le bassin houiller de la Lorraine française.* *By* FRANCIS LAUR. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1905, *vol. cxl.*, *pages* 267-268.

The borings put down at several points along the axis of Saarbrücken-Pont-à-Mousson, determined by the author in 1900, reveal a remarkable regularity in the strata which intervene between the surface and the Coal-measures. The entire Keuper series (Upper, Middle and Lower) does not exceed 660 feet in thickness, and the boring-tools (especially those planned on the Fauvel system) go through it with the utmost ease. This may be said, too, of the underlying Muschelkalk, which is only 525 feet thick. The water-bearing Bunter grits are but 230 feet thick at most; the exceedingly homogeneous Vosges grits, however, are more than 750 feet thick, and between them and the Coal-measures are intercalated mere films, as it were, of red Permian rocks. Towards Lesménils, however, on the north of the basin, the Permian begins to appear in the form of conglomerates awkward for the boring-tool. On the whole, the average depth at which the Coal-measures lie barely amounts to 2,300 feet, and this points to an enormous planing-down having taken place after Permian times, over an area the extent of which is hardly yet measurable.

(4) *Découverte de la Houille exploitable en Lorraine française.* *By* FRANCIS LAUR. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1905, *vol. cxl.*, *pages* 898-899.

The seam of perfectly pure and compact coal, 2·6 feet thick, proved at a depth of 2,670 feet in a boring at Pont-à-Mousson, is presumably the same seam as that which was struck at Éply in September, 1904, at a depth of

about 2,296 feet. The author states that no less than fifteen borings are in progress in the new coal-field, which he believes will prove to be one of the most considerable in Northern Europe: he claims that it will be found to extend in breadth for 15½ miles, that is, north of Nancy, and in length for some distance below the Paris basin.

(5) *Sur les Recherches de Houille en Meurthe-et-Moselle.* *By* R. NICKLÈS. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1905, *vol. cxl., pages* 896-898.

The author is chiefly concerned with the Éply and Lesménils borings, both of which got down to the Coal-measures in the course of 1904. An accident (in the autumn of that year) caused the stoppage of the Éply boring at a depth of 2,480 feet after passing through two thin seams of coal. At the time of writing, the boring-tool had been recaptured, and operations were being restarted. The Coal-measures here appeared to consist mainly of conglomerates and clay-slates. In the Lesménils boring, the Coal-measures were reached on August 22nd, 1904, at a depth of 2,545 feet from the surface, and the depth of 4,493 feet has now been attained without striking anything more satisfactory than some few carbonaceous venules. These barren measures consist, for the greater part, of sandy shales and conglomerates, and the dip is so steep that the utilizable thickness of Coal-measures would in any case be considerably diminished. There is reason to believe that the horizons represented at Lesménils belong to a higher or later group than the Coal-measures of Pont-à-Mousson. The author had in 1902 indicated the probable position of the axis of the anticline which passes through Éply and Atton, basing his predictions on the folds produced by movements of later age in the overlying Mesozoic or Secondary rocks. This anticline is markedly different from the domes and basins which characterize the tectonic structure of German Lorraine, and are repeated elsewhere in Meurthe-et-Moselle; but that implies no unfavourable presumption in regard to the possible productiveness in coal of those other districts of Meurthe-et-Moselle. The author refers to the red and purplish staining of the uppermost portion of the Westphalian shales in this anticline, due doubtless to highly-mineralized waters percolating downward from the overlying Triassic grit. We have here evidence of the removal by erosion of the Permian, the Stephanian, and a small portion of the Westphalian deposits, before the Trias was laid down unconformably upon the old Coal-measure surface. Were it not for that erosion, the Coal-measures could not possibly have been reached at anything like workable depths in French Lorraine.

(6) *Sur la Découverte de la Houille à Abaucourt* (*Meurthe-et-Moselle*). *By* RENÉ NICKLÈS; *and*

(7) *Observations relatives à la Note précédente de M. Nicklès.* *By* R. ZEILLER. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1905, *vol. cxli., pages* 66-69.

On June 26th, 1905, a coal-seam, 8·7 feet thick, was struck at a depth of 2,939 feet from the surface, in the Abaucourt boring, near Nomeny, in the department of Meurthe-et-Moselle. According to the preliminary chemical analyses made of the mineral, it contains about 41 per cent. of volatile substances and yields 3·57 per cent. of ash, a result analogous to those obtained with the Saarbrücken gas-coals. The boring was begun on December 8th, 1904, at an altitude of 620 feet above sea-level, and the Palæozoic strata were reached at a depth of 2,722 feet from the surface.

A boring put down at Laborde, 1·86 miles south of Abaucourt, as the

crow flies, reached Palæozoic rocks at a depth of 2,817 feet or so from the surface, and on June 3rd, 1905, at a depth of 3,257 feet a small coal-seam about 8 inches thick, was struck. If the foldings of the strata follow their normal course in this area, and are not thrown out by unsuspected faults, the horizon struck at Laborde is somewhat higher than that proved at Abaucourt, and consequently there is some hope that the seam found at the latter place will be ultimately discovered at the former also.

Prof. R. Zeiller, having examined the plant-remains obtained from the Coal-measures at Abaucourt, is inclined to correlate those strata with the upper portion of the Middle Saarbrücken group (that is, with the *Obere Flammkohlen*, or Upper Gas-coals). He points out that the horizon is very different from those struck at Éply, Pont-à-Mousson, Lesménils and Atton, localities lying to the north of the Nomeny fault. In these four localities the measures may be regarded as intermediary between the Lower Gas-coals (*Liegende Flammkohlen*) and the Bituminous coal-group (*Fettkohlen-gruppe*) which constitutes the basement of the Saarbrücken Coal-measures.

(8) *Sur les Plantes houillères des Sondages d'Éply, Lesménils, et Pont-à-Mousson (Meurthe-et-Moselle).* By R. ZEILLER. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1905, *vol. cxl., pages* 837-840.

This paper deals with the plant-remains obtained from the borings put down at three separate localities. At Éply, in reddish or purplish shales which had all the appearance of Permian rocks, various species of Coal-measure plants were obtained between the depths of 2,234 and 2,245 feet, forming a well-characterized assemblage of the Westphalian flora. Two species got at Éply (*Neuropteris rarinervis* and *Linopteris obliqua*) are typical of the upper horizons of the Westphalian, and in the Valenciennes basin make their first appearance near the top of the middle stage, reaching their acme in the upper stage. In the grey shales passed through between the depths of 2,245 and 2,263 feet, these two ferns were again obtained, as also *Neuropteris heterophylla* and *N. tenuifolia*, with other plants reminiscent of those which characterize the Saarbrücken Coal-measures. At 2,411 and 2,420 feet also, *Pecopteris*, *Linopteris* and *Sphenophyllum* were obtained. Very similar results ensue from an examination of the ferns and other plants brought up from various depths between 2,640 and 3,719 feet in the Lesménils boring: they include two species (*Lonchopteris Defrancei* and *Cingularia typica*) which have been hitherto found in the Saarbrücken basin alone. This forms an interesting addition to the evidence that the coal-field of French Lorraine is a prolongation of that basin. From Pont-à-Mousson, between the depths of 2,656 and 2,683 feet, at no great distance from the roof of the first coal-seam proved there, another assemblage of Westphalian plants was obtained. L. L. B.

THE SEARCH FOR COAL IN PICARDY, FRANCE.

La Houille en Picardie : du Raccordement des Bassins Houillers de l'Angleterre avec ceux de la Westphalie. By J. HERMARY. *Annales de la Société géologique du Nord*, 1904, *vol. xxxiii., pages* 89-101, *with 2 figures in the text, and 1 plate.*

The author points out that, in the search for the basins in which the Coal-measures lie, the prospector must trace out carefully the so-called Hercynian ridges, which resulted from the movements of uplift that took place in all parts of the globe after the close of Devonian time. A typical

example is the great ridge that can be followed from the Harz, through the Ardennes, the Mendips, South Wales, and Ireland to Bantry bay, re-emerging on the American shore of the Atlantic. In the troughs alongside this ridge the Coal-measures were laid down; at a subsequent period, phenomena of a sufficiently cataclysmic character occurred to thrust the Devonian and Silurian strata over the Coal-measures, shear these off in part, and drag them along for miles to the northward together with the overturned Carboniferous Limestone. Thus was formed the massif of the Condroz; the impelling force evidently came from the southward, and obviously acted in post-Coal-measure time. But yet another phenomenon is traced to the great pre-Coal-measure uplift; secondary folds were formed in the earth's crust, following the alignment of the great ridge, and recalling (after a fashion) the concentric rippling of water when a stone has been thrown into it. So again in the secondary troughs, given favourable conditions, Coal-measures were laid down. The discovery of the basin of Belgian Limburg and the Campine, between Sittard and Antwerp, fits in excellently with this theory; and so too does the alignment of those coal-fields in England which lie to the north of the great Hercynian ridge. The Belgian geologist, Prof. X. Stainier, having confined himself, in his recently published memoir, to the region north of that ridge, the author conversely confines himself to the area south of it, which he terms the South Hercynian tract. He affirms that undiscovered coal-fields are aligned parallel with the great ridge in this tract; a line drawn in that direction across the Channel from Exeter would perhaps strike St. Valéry-sur-Somme; and the hypothetical coal-field which underlies Picardy would join up with the Dinant basin through Péronne and Amiens. Péronne the author regards as the most hopeful locality at which to start the first trial-boring. In the estuary of the Somme, however, one need not expect to strike the Palæozoic rocks at a depth of much less than 2,000 feet below the surface.

Prof. J. Gosselet, although disagreeing with many of the theoretical considerations put forward by the author, agrees with him in recommending the prosecution of a search for coal in Picardy, and he thinks that it is just possible that the synclinal folds are not so closely packed together there as in the Condroz and the Avesnes district, and that some of them will prove to contain workable coal. L. L. B.

MODE OF FORMATION OF PAS-DE-CALAIS COAL.

Sur le Mode de Formation de la Houille du Pas-de-Calais. *By* CHARLES BARROIS. *Annales de la Société géologique du Nord*, 1904, *vol. xxxiii., pages* 156-172.

Premising that coal consists of vegetable remains, in different stages of decomposition, enclosing within their interstices amorphous brown substances which both envelop and penetrate them, the author points out that three successive phases are distinguishable in its formation. First, the accumulation of the vegetable matter; then, the work done by chemical reactions under water (this point is especially emphasized), including more or less complete dehydration and deoxidation of the cellulose, with consequent liberation of water, carbon dioxide and marsh-gas. According as the elimination of hydrogen and oxygen approximates to greater or less completeness, the coal produced will evidently vary in character. During this second phase, shrinkage of the mass takes place, amounting to from

10 to 30 per cent. of the original volume of the accumulated vegetable matter. The third phase consists in the work subsequently done by chemical reactions underground: this is the phase of "posthumous molecular displacement," wherein the vegetable remains are bituminized, or, as the case may be, silicified, ferruginized and pyritized. Liberation of hydrocarbon and oxidic gases is one of the results, as also the ultimate increase of the percentage of carbon in the coal. Anthracite is defined as a coal especially rich in carbon, and graphite as an anthracite from which all volatile matter has been expelled. A tabular view of the average chemical composition and specific gravity of the series—wood, peat, lignite, coal, anthracite and graphite is given, and is intended to impress the reader with the fundamental notion of the unity of origin of all fuels. The differences which they present are assignable to the successive and cumulative action of several factors during the various phases of formation of the rock. In the first phase, diverse floras have contributed to its structure, vascular cryptogams predominating in the Coal-measures, gymnosperms in the lignites, and monocotyledons in the peat of Northern France, etc. In the final phase, time and pressure were powerfully-contributing factors in the slow chemical reactions which were then taking place. The older the deposit, the greater appears to be the transformation that has been effected. On the other hand, investigation of the vegetable deposits of one period alone (say, the Carboniferous) in rocks subjected to increasing dynamic action, will show that the horizontal lignites of Moscow are replaced by the folded seams of bituminous coal in Central France, by the more tightly packed lean coal in the North of France, by the anthracite and even the graphite in the metamorphosed region of the Alps. Time and pressure, then, are both determining factors, in regard to the differences observable between the vegetable deposits of different basins.

In the Pas-de-Calais, at least six varieties of coal are recognized, ranging in percentage of carbon from 75 to 95, in that of oxygen and nitrogen from 19·5 to 3, and in that of hydrogen from 5·5 to 1. Volatile matter correspondingly varies from 45 per cent. to 8, and the specific gravity from 1·25 to 1·70. The causes of these differences are extremely various: but one is certainly to be found in the different character of the vegetable remains from which the seam originated. Then, the conditions of maceration varied according to the depth of the water overlying the deposits. The thickness of the deposit itself determines variations in dessication, aëration, pressure, etc., and so too does the nature of the roof. The character of the basins in which the deposits were laid down is also an important factor. Attention is finally drawn to the diminution of volatile matter according to the depth at which a seam is situated in the series (known as Hilt's law since 1873), and to the similar diminution from south to north in the Pas-de-Calais, assignable to the rise of the geothermic degree produced by tectonic folding.

The percentage of volatile matter is independent of the nature of the barren measures, as well as of the faults which traverse the rocks, showing that the variation in the coal had taken place before these faults.

L. L. B.

—REPORT OF THE CORRESPONDING SOCIETIES COMMITTEE OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, CAMBRIDGE, 1904.*

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The following Corresponding Societies nominated delegates to represent them at the Conferences:—The Institution of Mining Engineers, Rev. G. M. Capell; the Manchester Geological and Mining Society, Prof. W. Boyd Dawkins; the Midland Counties Institution of Engineers, Rev. G. M. Capell; the Midland Institute of Mining, Civil and Mechanical Engineers, Rev. G. M. Capell; the North of England Institute of Mining and Mechanical Engineers, Rev. G. M. Capell.

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First Conference, September 8th, 1904.

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In answer to a question by Captain Dubois Phillips, R.N., the Secretary (Mr. F. W. RUDLER) said that the question of the reduction of railway rates for members of scientific societies had been under the discussion of the Committee, but no definite result had yet been attained. It was a matter involving considerable difficulty.

The CHAIRMAN said he thought that naturalists should be treated as generously as anglers. He thought the most effective way of taking action would be to ask the committee to draw up a statement and forward it to all the affiliated societies with a request that they would sign it, so that there would be united representation from all parts of the country. He believed that if the presidents and secretaries signed a statement and sent it to the managers of the railways, they would probably effect their purpose. He suggested that the delegates should ask the Committee if they could see their way to discuss this matter, and, if possible, draw up a memorial.

Dr. ABBOTT proposed that the matter should be referred to the Corresponding Societies Committee to consider and take action. This was seconded and agreed to.

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Second Conference, August 23rd, 1904.

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The CHAIRMAN (Principal E. H. Griffiths), in opening the proceedings, s that he had ventured to take a certain kind of action of his own initiative a their last meeting, which he was going to ask the Conference to be good eno if they thought fit, to confirm. He thought the remarks that were made o proposal which he put before the congress from the chair at the last meetir to the conclusion that the delegates would uphold, and were in sympath the view that we ought to bring a larger number of our societies into tou the British Association, and that the union between the society and the Association should be a more real one than it is at present. The speaker

* By permission of the Council of the British Association for the Advancement

to translate the opinion of the meeting as that, and there was no voice to the contrary. On the other hand, the question he put forward of the possibility of establishing a *Journal of Corresponding Societies* was obviously one on which there were many differences of opinion; but, in any case, it must be remembered that the conference could take no action without the council of the Association. The chairman thought it was inadvisable to put things off until next year, because it would be very difficult to get anything like the ordinary business done then, and unless he had submitted a recommendation to the Committee of Recommendations before its meeting yesterday, all opportunity of doing anything would have been practically lost for the next two years. Therefore, on his own responsibility—and he stated at the time that it was on his own responsibility—he handed in a notice to go on the agenda-paper of the Committee of Recommendations to the following effect:—"That a committee be appointed, consisting of members of the council of the association, together with representatives of the Corresponding Societies, to consider the present relation between the British Association and local scientific sccieties. That the Committee be empowered to make suggestions to the Council with a view to the greater utilisation of the connection between the Association and the affiliated societies, and the extension of affiliation to other societies which are at present excluded under Regulation I."

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The resolution was carried unanimously and with applause.

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Committees appointed by the General Committee at the Cambridge Meeting in August, 1904.

1.—Receiving Grants of Money.

Subject for Investigation or Purpose.	Members of the Committee.	Grants.
Seismological observations	*Chairman.*—Prof. J. W. Judd. *Secretary.*—Mr. J. Milne. Lord Kelvin, Prof. T. G. Bonney, Mr. C. V. Boys, Prof. G. H. Darwin, Mr. Horace Darwin, Major L. Darwin, Prof. J. A. Ewing, Mr. M. H. Gray, Dr. R. T. Glazebrook, Prof. C. G. Knott, Prof. R. Meldola, Mr. R. D. Oldham, Prof. J. Perry, Mr. W. E. Plummer, Prof. J. H. Poynting, Mr. Clement Reid, Mr. Nelson Richardson and Prof. H. H. Turner.	£ 40 a. 0 d. 0
To co-operate with the Committee of the Falmouth Observatory in their magnetic observations.	*Chairman.*—Sir W. H. Preece. *Secretary.*—Dr. R. T. Glazebrook. Prof. W. G. Adams, Captain Creak, Mr. W. L. Fox, Prof. A. Schuster and Sir A. W. Rücker	50 0 0
To investigate the erratic blocks of the British Isles, and to take measures for their preservation.	*Chairman.*—Mr. J. E. Marr. *Secretary.*—Prof. P. F. Kendall. Prof. T. G. Bonney, Mr. C. E. De Rance, Prof. W. J. Sollas, Mr. R. H. Tiddeman, Rev. S. N. Harrison, Dr. J. Horne, Mr. F. M. Burton, Mr. J. Lomas, Mr. A. R. Dwerryhouse, Mr. J. W. Stather, Mr. W. T. Tucker and Mr. F. W. Harmer.	10 0 0 and unexpended balance
The movements of underground waters of north-west Yorkshire.	*Chairman.*—Prof. W. W. Watts. *Secretary.*—Mr. A. R. Dwerryhouse. Prof. A. Smithells, Rev. E. Jones, Mr. Walter Morrison, Mr. G. Bray, Rev. W. Lower Carter, Mr. T. Fairley, Prof. P. F. Kendall and Dr. J. E. Marr.	Balance in hand.

1.—Receiving Grants of Money.—*Continued.*

Subject for Investigation or Purpose.	Members of the Committee.	Grants. £ s. d. Balance in hand.
To study life-zones in the British Carboniferous rocks.	*Chairman.*—Mr. J. E. Marr. *Secretary.*—Dr. Wheelton Hind. Mr. F. A. Bather, Mr. G. C. Crick, Mr. A. H. Foord, Mr. H. Fox, Prof. E. J. Garwood, Dr. G. J. Hinde, Prof. P. F. Kendall, Mr. R. Kidston, Mr. G. W. Lamplugh, Prof. G. A. Lebour, Mr. B. N. Peach, Mr. J. T. Stobbs, Mr. A. Strahan, Mr. D. T. Gwynne Vaughan and Dr. H. Woodward.	
To report upon the course of experimental, observational and practical studies most suitable for elementary schools.	*Chairman.*—Sir Philip Magnus. *Secretary.*—Mr. W. M. Heller. Sir W. de W. Abney, Mr. R. H. Adie, Prof. H. E. Armstrong, Miss A. J. Cooper, Miss L. J. Clarke, Mr. George Fletcher, Prof. R. A. Gregory, Principal E. H. Griffiths, Mr. A. D. Hall, Mr. A. J. Herbertson, Dr. C. W. Kimmins, Prof. J. Perry, Mrs. W. N. Shaw, Prof. A. Smithells, Dr. Lloyd Snape, Principal Reichel, Mr. H. Richardson, Mr. Harold Wager, Miss Edna Walter and Prof. W. W. Watts.	20 0 0
Corresponding Societies Committee for the preparation of their report.	*Chairman.*—M. W. Whitaker. *Secretary.*—Mr. F. W. Rudler. Rev. J. O. Bevan, Dr. H. T. Brown, Dr. Vaughan Cornish, Principal E. H. Griffiths, Mr. T. V. Holmes, Mr. J. Hopkinson, Prof. R. Meldola, Dr. H. R. Mill, Mr. C. H. Read, Rev. T. R. R. Stebbing, Prof. W. W. Watts and the General Officers of the Association.	20 0 0
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2.—Not Receiving Grants of Money.

Subject for Investigation or Purpose.	Members of the Committee.
The rate of increase of underground temperature downwards in various localities of dry land and under water.	*Chairman and Secretary.*—Prof. H. L. Callendar. Lord Kelvin, Sir Archibald Geikie, Prof. Edward Hull, Prof. A. S. Herschel, Prof. G. A. Lebour, Dr. C. H. Lees, Mr. A. B. Wynne, Mr. W. Galloway, Mr. Joseph Dickinson, Mr. G. F. Deacon, Mr. Edward Wethered, Mr. A. Strahan, Prof. Michie Smith, and Mr. B. H. Brough.
The consideration of the teaching of elementary mechanics, and the improvement which might be effected in such teaching.	*Chairman.*—Prof. Horace Lamb. *Secretary.*—Prof. J. Perry. Mr. C. Vernon Boys, Profs. Chrystal, Ewing, G. A. Gibson, and Greenhill, Principal Griffiths, Prof. Henrici, Dr. E. W. Hobson, Mr. C. S. Jackson, Sir Oliver Lodge, Profs. Love, Minchin and Schuster and Mr. A. W. Siddons.
The collection, preservation, and systematic registration of photographs of geological interest.	*Chairman.*—Prof. J. Geikie. *Secretary.*—Prof. W. W. Watts. Prof. T. G. Bonney, Dr. T. Anderson, Profs. E. J. Garwood and S. H. Reynolds, and Messrs. A. S. Reid, W. Gray, H. B. Woodward, R. Kidston, J. J. H. Teall, J. G. Goodchild, H. Coates, C. V. Crook, G. Bingley, B. Welch and W. J. Harrison.
To record and determine the exact significance of local terms applied in the British Isles to topographical and geological objects.	*Chairman.*—Mr. Douglas W. Freshfield. *Secretary.*—Mr. W. G. Fearnsides. Lord Avebury, Mr. C. T. Clough, Prof. E. J. Garwood, Mr. E. Heawood, Dr. A. J. Herbertson, Col. D. A. Johnston, Mr. O. T. Jones, Dr. J. S. Keltie, Mr. G. W. Lamplugh, Mr. H. J. Mackinder, Dr. E. J. Marr, Dr. H. R. Mill, Mr. H. Yule Oldham, Dr. B. Peach, Prof. W. W. Watts and Mr. H. B. Woodward.
To investigate the resistance of road vehicles to traction.	*Chairman.*—Sir J. I. Thornycroft. *Secretary.*—Mr. A. Mallock. Mr. T. Aitken, Mr. T. C. Aveling, Prof. T. Hudson Beare, Mr. W. W. Beaumont, Mr. J. Brown, Col. R. E. Crompton, Mr. B. J. Diplock, Prof. J. Perry, Sir D. Salomons, Mr. A. R. Sennett, Mr. E. Shrapnell Smith and Prof. W. C. Unwin.
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Full Title and Date of Foundation.	Abbreviated Title.	Head-quarters or Name and Address of Secretary.	No. of Members.	Entrance Fee.	Annual Subscription.	Title and Frequency of Issue of Publications.
Andersonian Naturalists' Society, 1885	Andersonian Nat. Soc.	204, George Street, Glasgow. R. Barnett Johnstone and T. Nisbet.	261	None	2s. 6d.	Annals, occasionally.
Bath Natural History and Antiquarian Field Club, 1855	Bath N. H. A. F. C. ..	J. Langfield Ward, Royal Literary and Scientific Institution, Bath.	80	5s.	10s.	Proceedings, annually.
Belfast Natural History and Philosophical Society, 1821	Belfast N. H. Phil. Soc.	Museum, College Square. R. M. Young, M.R.I.A.	242	None	£1 1s.	Report and Proceedings, annually.
Belfast Naturalists' Field Club, 1863..	Belfast Nat. F. C. ..	Museum, College Square. N. H. Foster and James Orr.	375	5s.	5s.	Report and Proceedings, annually.
Berwickshire Naturalists' Club, 1831..	Berwickah. Nat. Club ..	Rev. J. J. M. L. Aiken, B.D., Manse of Ayton, Berwickshire.	400	None	10s.	History of the Berwickshire Naturalists' Club, annually.
Birmingham and Midland Institute Scientific Society, 1859	Birm. & Mid. Inst. Sci. Soc.	Alfred Cresswell, Birmingham and Midland Institute, Paradise Street, Birmingham.	140	None	£1 6s.	Records of Meteorological Observations, annually.
Birmingham Natural History and Philosophical Society, 1858	Birm. N. H. Phil. Soc.	Norwich Union Chambers, Congreve Street, Birmingham. W. P. Marshall and W. B. Grove, M.A.	174	None	£1 1s.	Proceedings, annually.
Bristol Naturalists' Society, 1862 ..	Bristol Nat. Soc. ..	S. H. Reynolds, M.A., University College, Bristol.	152	5s.	10s.	Proceedings, annually.
Buchan Field Club, 1887	Buchan F. C.	J. F. Tocher, F.I.C., 5, Chapel Street, Peterhead.	170	5s.	5s.	Transactions, annually.
Burton-on-Trent Natural History and Archæological Society, 1876	Burt. N. H. Arch. Soc..	B. L. Oswell, 5, Balmoral Road, Burton-on-Trent.	210	None	5s.	Annual Report. Transactions, occasionally.
Caradoc and Severn Valley Field Club, 1893	Car. & Sev. Vall. F. C...	H. E. Forrest, 37, Castle Street, Shrewsbury.	168	5s.	5s.	Transactions and Record of Bare Facts, annually.
Cardiff Naturalists' Society, 1867 ..	Cardiff Nat. Soc. ..	Wm. Sheen, M.S., 2, St. Andrew's Crescent, Cardiff	450	None	15s.	Transactions, annually.
Chester Society of Natural Science, Literature and Art, 1871	Chester Soc. Nat. Sci...	Grosvenor Museum, Chester. G. P. Mîln and W. F. J. Shepheard.	1011	None	5s.	Report and Proceedings, annually.
Cornwall, Royal Geological Society of, 1814	Cornw. R. Geol. Soc. ..	The Museum, Public Buildings, Penzance. John B. Cornish.	96	None	£1 1s.	Report and Transactions, annually.
Croydon Natural History and Scientific Society, 1870	Croydon N. H. Sci. Soc.	Public Hall, Croydon. G. W. Moore.	200	None	10s.	Proceedings and Transactions, annually.
Dorset Natural History and Antiquarian Field Club, 1875	Dorset N. H. A. F. C. ..	Rev. Herbert Pentin, M.A., Milton Abbey Vicarage, Dorset.	361	10s.	10s.	Proceedings, annually.
Dublin Naturalists' Field Club, 1885 .	Dublin N. F. C.	J. de W. Hinch, National Library of Ireland, Dublin.	154	5s. Associates, none	5s. Associates, 2s. 6d.	*Irish Naturalist*, monthly. Report, annually.
East Kent Scientific and Natural History Society, 1857	E. Kent S. N. H. Soc...	A. Lander, The Medical Hall, Canterbury.	102	None	10s.	Transactions, annually.
Eastbourne Natural History Society, 1867	Eastbourne N.H. Soc...	E. J. Bedford, Anderida, Gorringe Road, Eastbourne	120	2s. 6d.	7s. 6d.	Transactions, annually.
Edinburgh Geological Society, 1834..	Edinb. Geol. Soc. ..	India Buildings, Edinburgh, James Currie, M.A., F.R.S.E.	200	10s. 6d.	12s. 6d.	Transactions, annually.

THE CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION FOR 1904-1905.—*Continued.*

Full Title and Date of Foundation.	Abbreviated Title.	Head-quarters or Name and Address of Secretary.	No. of Members.	Entrance Fee.	Annual Subscription.	Title and Frequency of Issue of Publications.
Elgin and Morayshire Literary and Scientific Association	Elgin Lit. Sci. Assoc.	R. B. Gordon, Elgin	98	None	5s.	Transactions, occasionally.
Essex Field Club, 1880	Essex F. C.	William Cole, Springfield, Epping New Road, Buckhurst Hill, Essex.	300	None	15s.	*Essex Naturalist*, quarterly; *Special Memoirs*, &c., occasionally.
Glasgow, Geological Society of, 1858	Glasgow Geol. Soc.	J. Barclay Murdoch, Capelrig, Newton-Mearns, Glasgow.	230	None	10s.	Transactions, annually.
Glasgow, Natural History Society of, 1851	Glasgow N. H. Soc.	Alex. Ross, 2 Kennyhill Gardens, Dennistoun, Glasgow	297	None	7s. 6d.	Transactions and Proceedings, annually.
Glasgow, Royal Philosophical Society of, 1802	Glasgow R. Phil. Soc.	Dr. Freeland Fergus, 207, Bath Street, Glasgow.	1,000	£1 1s.	£1 1s.	Proceedings, annually.
Halifax Scientific Society, 1874	Halifax S. S.	Literary and Philosophical Society's Rooms, Harrison Road. F. Barker.	150	None	2s. 6d.	*Halifax Naturalist*, every two months
Hampshire Field Club and Archæological Society, 1885	Hants. F. C.	W. Dale, F.S.A., 5, Sussex Place, Southampton.	250	None	7s. 6d.	Proceedings, annually.
Haslemere Microscope and Natural History Society	Haslemere Mic. N. H. Soc.	Rev. G. B. Stallworthy, The Manse, Hindhead, Surrey.	400	None	Minimum, 2s.	Report, annually; Science Papers, occasionally.
Hertfordshire Natural History Society and Field Club, 1875	Herts. N. H. Soc.	A. E. Gibbs, F.L.S., St. Albans, and A Sutton, Watford.	200	10s.	10s.	Transactions, four times a year.
Holmesdale Natural History Club, 1857	Holmesdale N. H. C.	G. E. Frisby 1, Claudeboye Villas, Fengates Road, Redhill.	108	10s. and 5s.	10s. and 5s.	Proceedings, every two or three years.
Hull Geological Society, 1887	Hull Geol. Soc.	J. W. Stather, F.G.S., 16, Louis Street, Hull	75	None	5s.	Transactions, annually.
Hull Scientific and Field Naturalists' Club, 1886	Hull Sci. F. N. C.	T. Sheppard, F.G.S., The Museum, Hull.	180	None	5s.	Transactions, annually.
Institution of Mining Engineers, 1889	Inst. Min. Eng.	M. Walton Brown, Neville Hall, Newcastle-upon Tyne.	2,800	None	None	Transactions, monthly.
Inverness Scientific Society and Field Club, 1875	Inverness Sci. Soc.	E. G. Critchley, 29, High Street, Inverness.	195	None	5s.	Transactions, occasionally.
Ireland, Statistical and Social Inquiry Society of, 1847	Stat. Soc. Ireland	W. Lawson, Dr. N. M. Falkiner and C. H. Oldham, 35, Molesworth Street, Dublin.	100	None	£1.	Journal, annually.
Leeds Geological Association, 1873	Leeds Geol. Assoc.	Law Institute, Leeds. Walter Parsons.	84	None	5s.	Transactions, occasionally.
Leeds Naturalists' Club and Scientific Association, 1868	Leeds Nat. C Sci. Assoc.	J. M. Butler, 214, Tempest Road, Leeds.	90	None	6s.	Transactions, occasionally.
Leicester Literary and Philosophical Society, 1835	Leicester Lit. Phil. Soc.	Corporation Museum. W. A. Evans.	333 Members & Associates.	None	Members, £1 1s.; Associates, 10s. 6d.	Transactions, half-yearly.
Liverpool Engineering Society, 1875	Liverpool E. Soc.	R. C. F. Annett, 4, Buckingham Avenue, Sefton Park, Liverpool.	535	None	Resident, £1 1s.; Non-res. and Students, 10s. 6d.	Transactions and Report, annually.

Full Title and Date of Foundation.	Abbreviated Title.	Head-quarters or Name and Address of Secretary.	No. of Members.	Entrance Fee.	Annual Subscription.	Title and Frequency of Issue of Publications.
Liverpool Geographical Society, 1891	Liverpool Geog. Soc. ..	Capt. E. C. Dubois Phillips, R.N., 14, Hargreave's Buildings, Liverpool.	700	None	Members, £1 1s.; Associates, 10s. 6d.	Transactions and Report, annually.
Liverpool Geological Society, 1858 ..	Liverpool Geol. Soc. ..	Royal Institution. W. A. Whitehouse.	66	None	£1 1s.	Proceedings, annually.
Man, Isle of, Natural History and Antiquarian Society, 1879	I. of Man N. H. A. Soc.	T. E. Acheson. Lloyd's Bank, Ramsey, Isle of Man.	130	2s. 6d.	7s. 6d. and 5s.	*Yn Lioar Manninagh*, biennially.
Manchester Geographical Society, 1884	Manch. Geog. Soc. ..	F. Zimmern and J. H. Reed, 16, St. Mary's Parsonage, Manchester.	700	None	Members, £1 1s.; Associates, 10s. 6d.	Journal, quarterly; *Geography*, monthly
Manchester Geological and Mining Society, 1838	Manch. Geol. Min. Soc.	5, John Dalton Street, Manchester. W. Saint and J. Tonge, jun.	253	None	£1	Transactions, monthly.
Manchester Microscopical Society, 1880	Manch. Mic. Soc. ..	E. C. Stump, 16, Herbert Street, Moss Side, and A. E. Thompson, Wellington Road, Whalley Range, Manchester.	194	5s.	6s.	Transactions and Report, annually.
Manchester Statistical Society, 1833 ..	Manch. Stat. Soc. ..	Theodore Gregory, 3, York Street, Manchester.	210	10s. 6d.	10s. 6d.	Transactions, annually.
Marlborough College Natural History Society, 1864	Marlb. Coll. N. H. Soc.	Marlborough College. E. Meyrick ..	250	1s. 6d.	3s. and 5s.	Report, annually.
Midland Counties Institution of Engineers, 1871	Mid. Count. Inst. ..	G. Alfred Lewis, Albert Street, Derby.	420 Membs., Associates & Students	£1 1s. Non	Members £1 11s. 6d.; Associates and Students, £1	*Transactions of the Institution of Mining Engineers*, monthly.
Midland Institute of Mining, Civil and Mechanical Engineers, 1869	Mid. Inst. Eng.	T. W. H. Mitchell, Mining Offices, Regent Street, Barnsley.	300	None	£1 10s.	*Transactions of the Institution of Mining Engineers*, monthly.
Norfolk and Norwich Naturalists' Society, 1869	Norf. Norw. Nat. Soc.	W. A. Nicholson, St. Helen's Square, Norwich.	256	None	5s.	Transactions, annually.
North of England Institute of Mining and Mechanical Engineers, 1852	N. Eng. Inst.	M. Walton Brown, Neville Hall, Newcastle-upon-Tyne.	1,400	None	£1 5s. and £2 2s.	*Transactions of the Institution of Mining Engineers*, monthly.
North Staffordshire Field Club ..	N. Staff. F. C. .. .	W. Wells Bladen, Stone, Staffs.	469	5s.	5s.	Report and Transactions, annually.
Northamptonshire Natural History Society and Field Club, 1876	Northants. N. H. Soc...	H. N. Dixon, M.A., 23, East Park Parade, Northampton.	200	None	10s.	Journal, quarterly.
Northumberland, Durham, and Newcastle-upon-Tyne, Natural History Society of	Northumb. N. H. Soc...	Hancock Museum, Newcastle-upon-Tyne. Prof. M. C. Potter, M.A., and N. H. Martin, F.L.S.	450	None	£1 1s.	Transactions, annually.
Nottingham Naturalists' Society, 1852	Nott. Nat. Soc.	Prof. J. W. Carr, M.A., University College, Nottingham.	• 188	2s. 6d.	5s.	Report, annually.
Paisley Philosophical Institution, 1808	Paisley Phil. Inst. ..	J. Gardner, 3, County Place, Paisley.	500	5s.	7s. 6d.	Report, annually; Meteorological Obs., occasionally.

THE CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION FOR 1904–1905.—*Continued.*

Full Title and Date of Foundation.	Abbreviated Title.	Head-quarters or Name and Address of Secretary.	No. of Members.	Entrance Fee.	Annual Subscription.	Title and Frequency of Issue of Publications.
Perthshire Society of Natural Science, 1867	Perths. Soc. N. Sci. ..	Tay Street, Perth. S. T. Ellison ..	399	2s. 6d.	5s. 6d.	Transactions and Proceedings, annually.
Quekett Microscopical Club, 1865 ..	Quekett Club	A. Earland, Reading Villa, Denmark Street, Watford	380	None	10s.	Journal, half-yearly.
Rochdale Literary and Scientific Society, 1878	Rochdale Lit. Sci. Soc.	J. Reginald Ashworth, D.Sc., 105, Freehold Street, Rochdale.	248	None	6s.	Transactions, biennially.
Rochester Naturalists' Club, 1878 ..	Rochester N. C.	John Hepworth, Linden House, Rochester.	182	None	5s.	*Rochester Naturalist*, quarterly.
Somersetshire Archæological and Natural History Society, 1849	Somersetsh. A.N.H. Soc.	The Castle, Taunton. Lt.-Col. J. R. Bramble, Rev. F. W. Weaver and C. Tite.	615	10s. 6d.	10s. 6d.	Proceedings, annually.
South African Philosophical Society, 1877	S. African Phil. Soc. ..	G. M. Clark, South African Museum, Cape Town.	207	None	£2	Transactions, occasionally.
South-Eastern Union of Scientific Societies, 1896	S.-E. Union	Rev. R. Ashington Bullen, B.A., Pyrford Vicarage, Woking.	42 Societies	None	Minimum 5s.	*South-Eastern Naturalist*, annually.
Southport Literary and Philosophical Society	Southport Lit. and Phil. Soc.	A. H. Garstang, 20, Roe Lane, Southport.	151	None	5s.	Proceedings, annually.
South Staffordshire and East Worcestershire Institute of Mining Engineers, 1867	S. Staff. Inst.	Alexander Smith, M.Inst.C.E., 3, Newhall Street, Birmingham.	178	£1 1s. and 10s. 6d.	£1 11s. 6d. and £1 1s.	*Transactions of the Institution of Mining Engineers*, monthly.
Toronto, Astronomical Society of, 1884	Toronto Astr. Soc. .	Canadian Institute Building. J. R. Collins.	125	None	2 dollars	Transactions, annually.
Tyneside Geographical Society, 1887 ..	Tyneside Geogr. Soc. ..	Geographical Institute, Barras Bridge, Newcastle-upon-Tyne. Herbert Shaw, B.A., F.R.G.S.	1,200	None	10s. and 5s.	Journal, annually.
Warwickshire Naturalists' and Archæologists' Field Club, 1854	Warw. N. A. F. C. ..	Museum, Warwick. C. West, Cross Cheaping, Coventry.	99	2s. 6d.	5s.	Proceedings, annually.
Woolhope Naturalists' Field Club, 1851	Woolhope N. F. C. ..	Woolhope Club Room, Free Library, Hereford. H. Cecil Moore.	240	10s.	10s.	Transactions, biennially.
Yorkshire Geological and Polytechnic Society, 1837	Yorks. Geol. Poly. Soc.	Rev. Wm. Lower Carter, M.A., F.G.S., Hopton, Mirfield.	184	None	13s.	Proceedings, annually.
Yorkshire Naturalists' Union, 1861 .	Yorks. Nat. Union ..	The Museum, Hull. T. Sheppard, F.G.S.	400 and 2650, Associates 420	None	10s. 6d.	Transactions, annually; *The Naturalist*, monthly.
Yorkshire Philosophical Society, 1822	Yorks. Phil. Soc. ..	Museum, York. Dr. Tempest Anderson and C. E. Elmhirst.		None	£2	Report, annually.

CATALOGUE OF THE MORE IMPORTANT PAPERS, AND ESPECIALLY THOSE REFERRING TO LOCAL SCIENTIFIC INVESTIGATIONS, PUBLISHED BY THE CORRESPONDING SOCIETIES DURING THE YEAR ENDING MAY 31ST, 1904.*

Section A.—MATHEMATICAL AND PHYSICAL SCIENCE.

ASHWORTH, J. R. "Weather Warnings." *Trans. Rochdale Lit. Sci. Soc.*, vol. vii., pages 97-100, 1903.

GRAY, PROF. ANDREW. "Entropy." *Proc. Glasgow R. Phil. Soc.*, vol. xxxiv., pages 116-124, 1903.

GRIFFITH, GEORGE L. "Notes of Surveys and Levellings in Canada." *Trans. Inst. Min. Eng.*, vol. xxvi., pages 552-564, 1904.

HALBAUM, H. W. G. "The Common-sense Doctrine of Furnace-draught." *Trans. Inst. Min. Eng.*, vol. xxv., pages 700-716, 1903.

LATHAM, BALDWIN. "Croydon Bourne Flows," 44 pages. *Croydon N. H. Sci. Soc.*, 1904.

MEACHEM, F. G. (S. Staff. Inst.). "Underground Temperatures." *Trans. Inst. Min. Eng.*, vol. xxv., pages 267-275, 1904.

THACKER, S. L. "The Dynamics of the Winding-engine." *Trans. Inst. Min. Eng.*, vol. xxvi., pages 445-464, 1904.

THOMPSON, PROF. G. R. (Mid. Inst. Eng.). "The Transmission of Errors in Traverse-surveying." *Trans. Inst. Min. Eng.*, vol. xxvi., pages 75-86, 1903.

* * * * * * * * * *

Section B.—CHEMISTRY.

BRAND, MARK (Min. Inst. Scot.). "Calcination of Blackband Ironstone at Dumbreck." *Trans. Inst. Min. Eng.*, vol. xxv., pages 253-258, 1904.

BRITTAIN, J. H. "Manchester's Contribution to the Chemistry of the Nineteenth Century." *Trans. Rochdale Lit. Sci. Soc.*, vol. vii., pages 4-9, 1903.

BROWN, JOHN. Inaugural Address. "The Liquefaction of Gases." *Proc. Belfast N. H. Phil. Soc.*, 1902-1903, pages 21-29, 1903.

HARDWICK, F. W. "Underground Fires." *Trans. Inst. Min. Eng.*, vol. xxv., pages 724-748, 1903.

MUIR, J. J. (N. Eng. Inst.). "An Improved Forced Method of Treatment of Low-grade Copper Ores." *Trans. Inst. Min. Eng.*, vol. xxvi., pages 40-44, 1903.

PENNINGTON, W. H. "A Lancashire Chemist [John Mercer]." *Trans. Rochdale Lit. Sci. Soc.*, vol. vii., page 21-25, 1903.

* * * * * * * * * *

Section C.—GEOLOGY.

ANDREWS, MISS MARY K. "Notes on some Igneous Rocks in Down and Antrim." *Proc. Belfast N. H. Phil. Soc.*, 1902-1903, pages 51-57, 1903.

ARBER, E. A. N. (N. Eng. Inst.). "The Use of Carboniferous Plants as Zonal Indices" *Trans. Inst. Min. Eng.*, vol. xxv., pages 371-380, 1904.

BALDWIN, WALTER. "*Belinurus bellulus* from Sparth, Rochdale." *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 198-202, 1903.

BARNES, J. "On a Fossil Polyzoa from the Mountain Limestone, Castleton." *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 243-244, 1903.

* Titles of Papers on other Subjects than Mining or Mechanical Engineering have not been reprinted.

BARNES, J. "The Microscopic Structure of Mountain Limestone." *Trans. Manch. Mic. Soc.*, 1902, pages 38-46, 1903.

BEASLEY, H. C. "Some Lithographs of Footprints, &c., from Storeton, issued by the Liverpool Natural History Society about 1839." *Proc. Liverpool Geol. Soc.*, vol. ix., pages 284-287, 1903.

BLACK, DR. W. G. "Gold-mining in the Transvaal." *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 234-239, 1903.

BOLTON, H. "The Palæontology of the Lancashire Coal-measures." *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 378-415, 1904.

BURNS, DAVID (N. Eng. Inst.). "The Gypsum of the Eden Valley." *Trans. Inst. Min. Eng.*, vol. xxv., pages 410-428, 1903.

BURTON, F. M. "Rhætic Beds at Lincoln." *The Naturalist* for 1903, pages 335-336, 1903.

CADMAN, JOHN (N. Staff. Inst.). "The Occurrence, Mode of Working, and Treatment of the Ironstones found in the North Staffordshire Coal-field." *Trans. Inst. Min. Eng.*, vol.xxvi., pages 106-119, 1903.

CLARKE, W. G. "The Meres of Wretham Heath." *Trans. Norf. Norw. Nat. Soc.*, vol. vii., pages 499-511, 1903.

COLLINS, J. H. "Notes on the Principal Lead-bearing Lodes of the West of England." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 683-718, 1903.

— Anniversary Address. "The Mining Industry of Cornwall." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 728-736, 1904.

CUDWORTH, W. "Carboniferous Vegetation at Bradford." *The Naturalist* for 1903, pages 266-267, 1903.

DAKYNS, J. R. "Notes on the Glacial Phenomena of part of Wharfedale, near Grassington, from my MS. written in 1878." *Proc. Yorks. Geol. Poly. Soc.*, vol. xv., pages 52-58, 1903.

DICKINSON, JOSEPH. "Cohesion of Strata overcome by Pressure and other Causes." *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 375-376, 1904.

DUTTON, G. H. "Notes on Glacial and Alluvial Deposits near Cardiff." *Trans. Cardiff Nat. Soc.*, vol. xxxvi., pages 109-115, 1904.

EDWARDS, W. "The Surface Geology of Cheshire in its relation to Agriculture." *Proc. Liverpool Geol. Soc.*, vol. ix., pages 292-301, 1903.

FOSTER, C. LE NEVE. Anniversary Address. "The Connexion between Place-names and Mineral Deposits." *Trans. R. Cornwall Geol. Soc.*, vol xii., pages 625-635, 1903.

FOX, HOWARD. "Some Coast Sections in the Parish of St. Minver." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 651-682, 1903.

"Supplementary Notes on some Coast-sections in the Parish of St. Minver." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 747-752, 1904.

— "Supplementary Notes on the Distribution of Fossils on the North Coast of Cornwall, South of the Camel." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 753-759, 1904.

HARKER, ALFRED. "Chemical Data for the Rocks of the English Lake District." *Proc. Yorks. Geol. Poly. Soc.*, vol. xv., pages 59-69, 1903.

HAWELL, REV. J. "An Oolitic Plant-bed in North Cleveland." *The Naturalist* for 1903, pages 312-317, 1903.

HOLMES, T. V. "On Some Greywethers at Grays Thurrock, Essex." *Essex Naturalist*, vol. xiii., pages 197-202, 1904.

HOWARD, F. T. "The Origin of the Physical Features of South Wales." *Trans. Cardiff Nat. Soc.*, vol. xxxvi., pages 21-51, 1904.

HOWARD, F. T. "Notes on Glacial Action in Brecknockshire and Adjoining Districts." *Trans. Cardiff Nat. Soc.*, vol. xxxvi., 92-108, 1904.

HOWARTH, JAMES H. "Notes on Boulder Markings on Mr. Kendall's Map of the Glacier Lakes on the Cleveland Hills." *Proc. Yorks. Geol. Poly. Soc.*, vol. xv., pages 46-51, 1903.

HUDLESTON, W. H. "Chesil Beach." *Proc. Dorset N. H. A. F. C.*, vol. xxiv., pages 1-9, 1903.

JOHNSON, J. P. "The Palæolithic Period in the Thames Basin." *Essex Naturalist*, vol. xiii., pages 97-110, 1903.

KENDALL, PERCY F. "The Glacier Lakes of Cleveland." *Proc. Yorks. Geol. Poly. Soc.*, vol. xv., pages 1-45, 1903.

KENDALL, PERCY F., and J. HOWARTH. "The Yorkshire Boulder Committee and its Seventeenth Year's Work, 1902-1903." *The Naturalist* for 1904, pages 13-18, 1904.

LOMAS, J. "Quartz-dykes near Foxdale, Isle of Man." *Proc. Liverpool Geol. Soc.*, vol. ix., pages 288-291, 1903.

LONES, DR. T. E. "On some Fossiliferous Post-Tertiary Beds exposed at the Gasworks, Watford." *Trans. Herts. N. H. Soc.*, vol. xii., pages 17-20, 1904.

MACALISTER, DONALD A. "A Cross-section and some Notes on the Tin and Copper Deposits of Camborne, with Special Reference to the Limits of Productive Ore-ground." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 773-795, 1904.

MACLAREN, J. MALCOLM (N. Eng. Inst.). "The Occurrence of Gold in Great Britain and Ireland." *Trans. Inst. Min. Eng.*, vol. xxv., pages 435-508, 1903.

MACNAIR, PETER. "The Building of the Grampians." *Proc. Glasgow R. Phil. Soc.*, vol. xxxiv., pages 147-224, 1903.

MILLET, F. W. "Note on the *Fanjasine* of the Tertiary Beds of St. Erth." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 718-719, 1903.

MOORE, C. C. Presidential Address. "The Study of the Volume-composition of Rocks (Part 2). The Examination of an Igneous Intrusion." *Proc. Liverpool Geol. Soc.*, vol. ix., pages 247-283, 1903.

PEARCE, RICHARD. "A Trachytic Boulder." *Trans. Cornwall R. Geol. Soc.*, vol. xii., page 760, 1904.

PEARSE, J. WALTER. "Luxemburg and its Iron-ore Deposits." *Trans. Inst. Min. Eng.*, vol. xxv., pages 580-589, 1903.

PEARSON, R. "The Discovery of Natural Gas in Sussex: Heathfield District." *Trans. Inst. Min. Eng.*, vol. xxvi., pages 494-503, 1904.

POSTLETHWAITE, J. (N. Eng. Inst.). "The Geology of the English Lake District." *Trans. Inst. Min. Eng.*, vol. xxv., pages 302-323, 1904.

PRESTON, HENRY. "Notes on the Geology and Archæology of the Caythorpe and Leadenham District." *The Naturalist* for 1903, pages 253-254, 1903.

ROGERS, A. "The Geological History of the Gouritz River System." *Trans. S. African Phil. Soc.*, vol. xiv., pages 375-384, 1903.

SAWYER, A. R. "Further Remarks on the Portuguese Manica Gold-field." *Trans. Inst. Min. Eng.*, vol. xxv., pages 637-642, 1903.

SCHWARZ, E. H. L. "An Unrecognised Agent in the Deformation of Rocks." *Trans. S. African Phil. Soc.*, vol. xiv., pages 385-402, 1903.

SCOTT, H. KILBURN. "The Mineral Resources of the State of Rio Grande do Sul, Brazil." *Trans. Inst. Min. Eng.*, vol. xxv., pages 510-524, 1903.

SHORT, A. RENDLE. "A New Theory of the Cotham Marble." *Proc. Bristol Nat. Soc.*, vol. x., pages 135-149, 1903.

SIMPSON, J. B. "The Probability of Finding Workable Seams of Coal in the Carboniferous Limestone or Bernician Formation, beneath the Regular Coal-measures of Northumberland and Durham, with an account of a Recent Deep Boring made, in Chopwell Woods, below the Brockwell Seam." *Trans. Inst. Min. Eng.*, vol. xxiv., pages 549-563, 1903.

SIMPSON, WILLIAM. "Record and Comparison of Three Deep Borings in the Millstone Grit Rocks at Halifax." *Halifax Naturalist*, vol. viii., pages 21-27, 1903. *Proc. Yorks. Geol. Poly. Soc.*, vol. xv., pages 79-90, 1903.

STATHER, J. W. "Quartzite Pebbles on the Yorkshire Wolds." *The Naturalist* for 1904, pages 9-11, 1904.

SUTCLIFFE, RICHARD. "Erratic and Water-worn Stones found in Fire-clay in the Hartley-bank Colliery, Horbury." *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 229-230, 1903.

SUTCLIFFE, W. H. "A Geological Ramble in Scotland." *Trans. Rochdale Lit. Sci. Soc.*, vol. vii., pages 30-46, 1903.

SUTTON, W. J. The Geology and Mining of Vancouver Island. *Trans. Manch. Geol. Min. Soc.*, vol. xxviii., pages 307-314, 1904.

THOMPSON, BEEBY. "The Junction Beds of the Upper Lias and Inferior Oolite in Northamptonshire. Part II." *Journal Northants N. H. Soc.*, vol. xii., pages 54-69, 1903.

TUTCHER, J. W. "The Lower Oolites near Bristol." *Proc. Bristol Nat. Soc.*, vol. x., pages 150-168, 1903.

VAUGHAN, A. "Notes on the Corals and Brachiopods obtained from the Avon Section, and preserved in the Stoddart Collection." *Proc. Bristol Nat. Soc.*, vol. x., pages 90-134, 1903.

WALKER, W. E. (N. Eng. Inst.). "Hæmatite Deposits and Hæmatite Mining in West Cumberland." *Trans. Inst. Min. Eng.*, vol. xxv., pages 292-298, 1904.

WELLBURN, EDGAR D. "On some New Species of Fossil Fish from the Millstone Grit Rocks, with an Amended List of Genera and Species." *Proc. Yorks. Geol. Poly. Soc.*, vol. xv., 70-78, 1903.

WHITLEY, Rev. D. GATH. "A Plea for the Study of Cornish Quaternary Geology." *Trans. Cornwall R. Geol. Soc.*, vol. xii., pages 761-772, 1904.

WOODWARD, Dr. HENRY. "East Anglian Geology – Historical Sketch. Dawn of the Science of Geology." *Trans. Norf. Norw. Nat. Soc.*, vol. vii., pages 477-498, 1903.

WOODWARD, H. B. "Notes on the Occurrence of Natural Gas at Heathfield, Sussex." *Trans. Inst. Min. Eng.*, vol. xxv., pages 717-723, 1903.

WOOLACOTT, D. "An Explanation of the Claxheugh Section, County Durham." *Trans. Northumb. N. H. Soc.*, vol. xiv., pages 211-221, 1903.

WRIGHT, JOSEPH. "The Micro-fauna of the Boulder Clay, with some Remarks on the Movement of Glaciers." *Proc. Belfast N. H. Phil. Soc.*, 1902-1903, pages 47-50, 1903.

— "The Foraminifera of the Boulder Clay of Knock Glen, county Down." *Proc. Belfast Nat. F.C.*, vol. v., pages 59-63, 1904.

— "Foraminiferal Boulder Clay from Woodburn, Carrickfergus." *Proc. Belfast Nat. F. C.*, vol. v., pages 109-114, 1904.

* * * * * * * * * *

Section D. – ZOOLOGY.

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Section E.—GEOGRAPHY.

COLQUHOUN, A. R. "Siam: Present and Future." *Journal Manch. Geog. Soc.*, vol. xix., pages 23-27, 1903.

HERBERT, J. H. "Iceland and its Volcanic Phenomena." *Report Nott. Nat. Soc.*, 1902-1903, pages 19-42, 1904.

INSKIPP, P. S. "Rhodesia." *Journal Manch. Geog. Soc.*, vol. xix., pages 73-84, 1904.

PORTILLO, PEDRO, translated by H. GUILLAUME. "The Peruvian Amazonian Basin, with its Prospects for Commerce and Colonization." *Journal Manch. Geog. Soc.*, vol. xviii., pages 153-162, 1903.

SAUNDERS, JAMES. "On the Shrinkage of the Upper Sources of the River Lea." *Trans. Herts. N. H. Soc.*, vol. xi., pages 227-235, 1903.

* * * * * * * * * *

Section F.—ECONOMIC SCIENCE AND STATISTICS.

BAILEY, WM. F. Presidential Address. "Ireland since the Famine.—A Sketch of Fifty Years' Economic and Legislative Changes." *Journal Stat. Soc. Ireland*, vol. xi., pages 129-154, 1904.

BROWN, RICHARD. "Early Scottish Joint-stock Companies" *Proc. Glasgow R. Phil. Soc.*, vol. xxxiv., pages 225-249, 1903.

CHALMERS, Dr. A. K. "The Death-rate in One-apartment Houses: An Enquiry based on the Census Returns of 1901." *Proc. Glasgow R. Phil. Soc.*, vol. xxxiv., pages 125-146, 1903.

FALKINER, C. L. "The Forestry Question considered Historically." *Journal Stat. Soc. Ireland*, vol. xi., pages 156-173, 1904.

KINAHAN, G. H. "The Re-development of the Slate Trade in Ireland." *Trans. Inst. Min. Eng.*, vol. xxv., 670-677, 1903.

MURRAY, ALEX. "The Glasgow Corporation Accounts, with Special Reference to Depreciation and Sinking Funds." *Proc. Glasgow R. Phil. Soc.*, vol. xxxiv., pages 79-105, 1903.

SCOTT, FRED. "The Case for a Ministry of Health." *Trans. Manch. Stat. Soc.*, 1902-1903, pages 97-176, 1903.

* * * * * * * * * *

Section G.—ENGINEERING.

ACKERMANN, A. S. E. "Pneumatic and Electric Locomotives in and about Coal-mines." *Trans. Inst Min. Eng.*, vol. xxv., pages 529-538, 1903.

BARMAN, H. D. D. (Min. Inst. Scot.). "The Riedler Pump." *Trans. Inst. Min. Eng.*, vol. xxv., pages 238-248, 1903.

BEST, W. (S. Staff. Inst.). "A Magnetic Unlocking and Electrically-ignited Safety-lamp." *Trans. Inst. Min. Eng.*, vol. xxv., page 265, 1904.

BORLASE, Wm. H. (N. Eng. Inst.). "Description of the Lead-ore Washing-plant at the Greenside Mines, Patterdale." *Trans. Inst. Min. Eng.*, vol. xxv., pages 331-338, 1904.

BRAGG, GEO. H. (N. Eng. Inst.). "Granite-quarrying, Sett-making, and Crushing; and the Manufacture of Concrete Flags and Granitic Tiles." *Trans. Inst. Min. Eng.*, vol. xxv., pages 340-352, 1904.

CHARLTON, WILLIAM. "Use of Ratchet and other Hand-machine Drills in the Cleveland Mines." *Trans. Inst. Min. Eng.*, vol. xxiv., pages 526-534, 1903.

CORMACK, A. CAMPBELL. "Electric Plant Failures, their Origin and Prevention." *Trans. Inst. Min. Eng.*, vol. xxv., pages 548-571, 1903.

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EXPLANATIONS.

The — at the beginning of a line denotes the repetition of a word; and in the case of Names, it includes both the Christian Name and the Surname; or, in the case of the name of any Firm, Association or Institution, the full name of such Firm, etc.

Discussions are printed in *italics*.

The following contractions are used:—

M.—Midland Institute of Mining, Civil and Mechanical Engineers.
M.C.—The Midland Counties Institution of Engineers.
M.G.—Manchester Geological and Mining Society.
S.—The Mining Institute of Scotland.
N.E.—The North of England Institute of Mining and Mechanical Engineers.
N.S.—North Staffordshire Institute of Mining and Mechanical Engineers.
S.S.—The South Staffordshire and East Worcestershire Institute of Mining Engineers.

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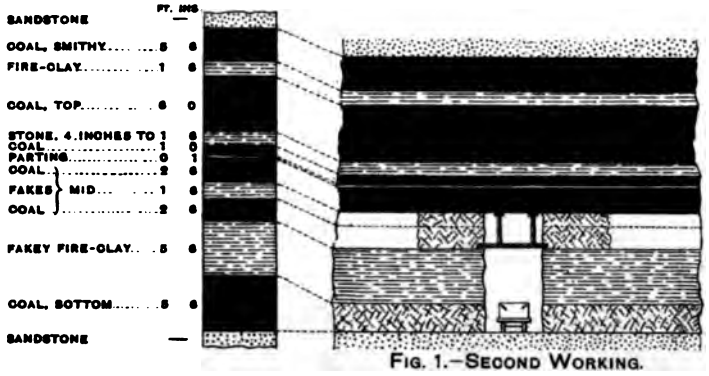


FIG. 1.—SECOND WORKING.

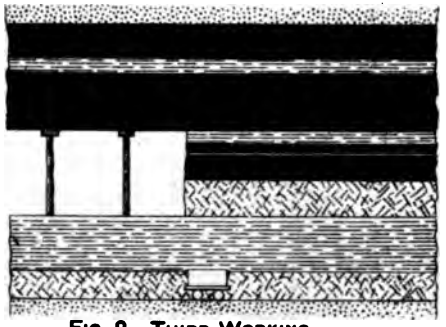


FIG. 2.—THIRD WORKING.

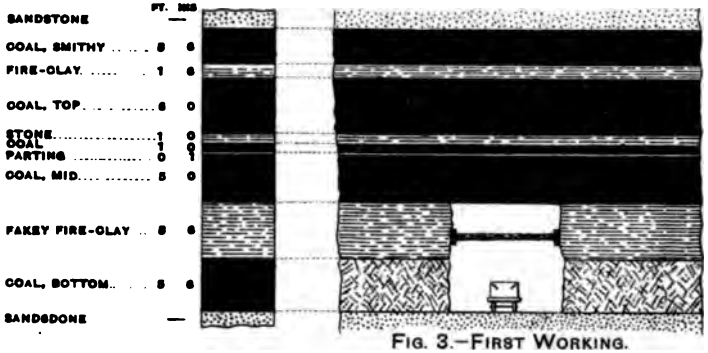


FIG. 3.—FIRST WORKING.

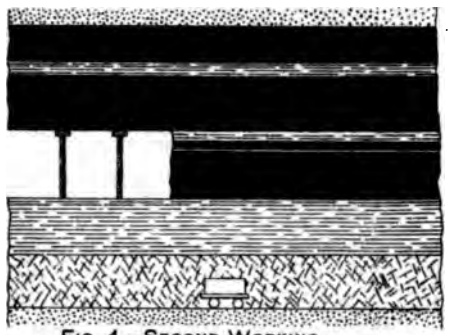


FIG. 4.—SECOND WORKING.

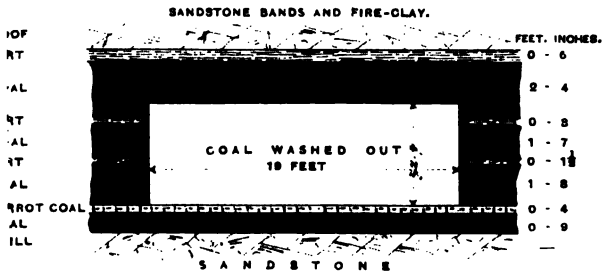
Scale, 20 Feet to 1 Inch.

And^w Reid & Comp^y L^td. Newcastle upon Tyne.

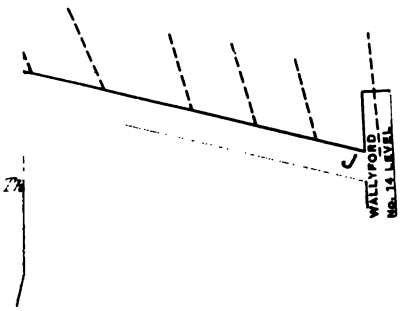
FIG. 3.—CROSS-SECTION AT B IN FIG. 1.

Horizontal Scale, 12 Feet to 1 Inch.
Vertical Scale, 8 Feet to 1 Inch.

FIG. 4.—CROSS-SECTION AT C IN FIG. 1.



Horizontal Scale, 12 Feet to 1 Inch.
Vertical Scale, 8 Feet to 1 Inch.



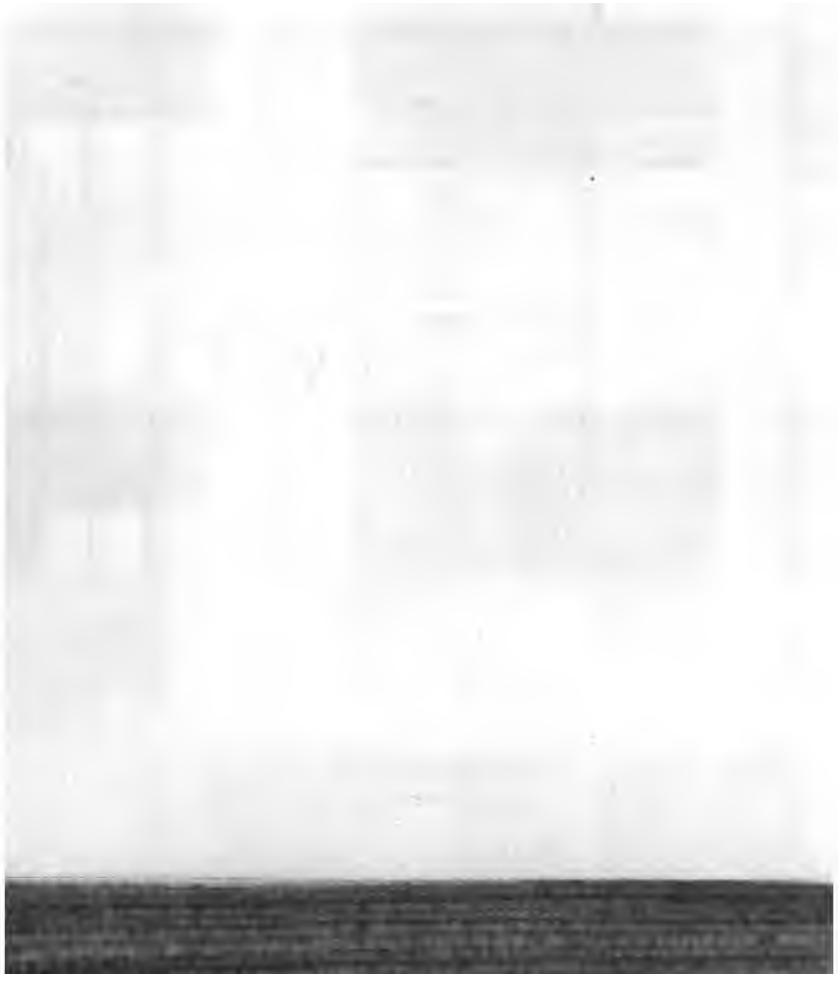
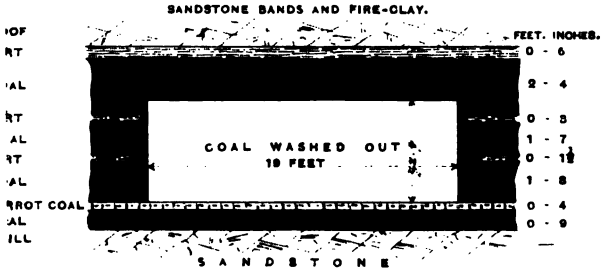


FIG. 3.—CROSS-SECTION AT B IN FIG. 1.

Horizontal Scale, 12 Feet to 1 Inch.
Vertical Scale, 8 Feet to 1 Inch.

FIG. 4.—CROSS-SECTION AT C IN FIG. 1.



Horizontal Scale, 12 Feet to 1 Inch.
Vertical Scale, 8 Feet to 1 Inch.

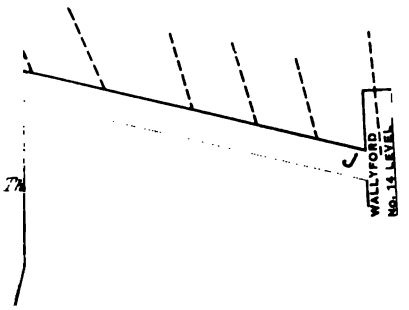


FIG. 2.

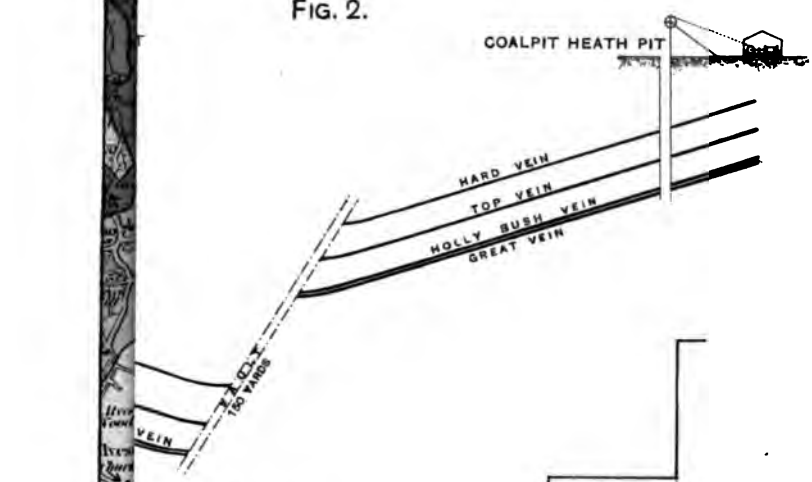
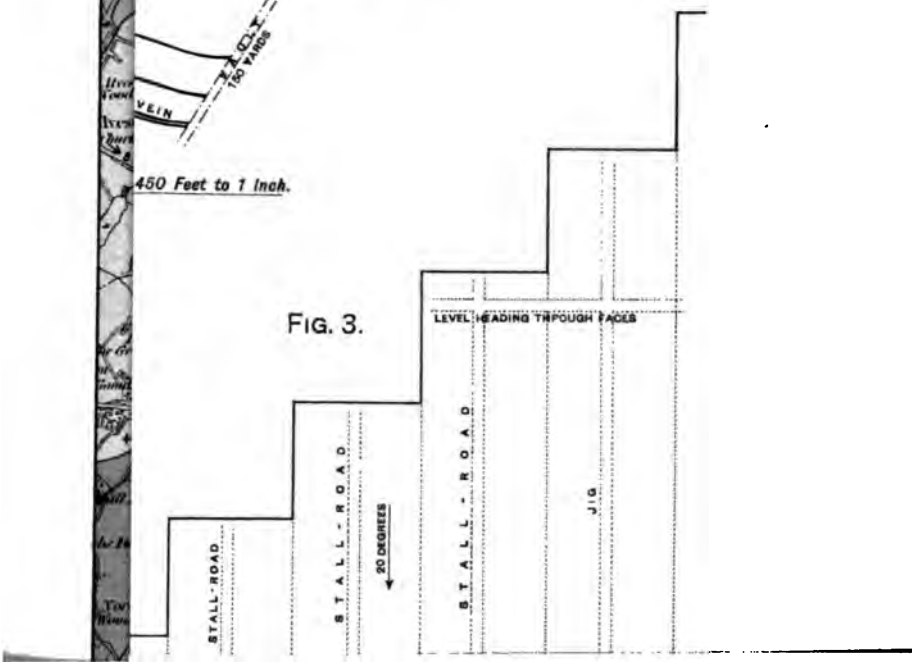
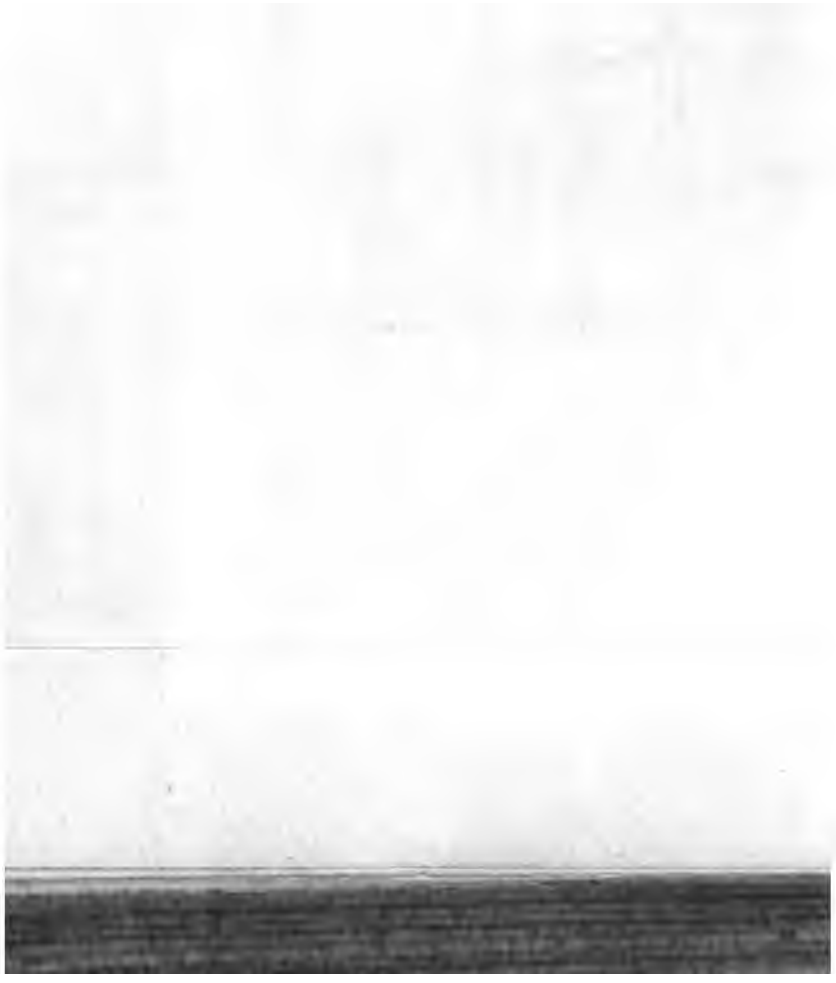

COALPIT HEATH PIT
HARD VEIN
TOP VEIN
HOLLY BUSH VEIN
GREAT VEIN
DIP
150 YARDS
VEIN
450 Feet to 1 Inch.

FIG. 3.


LEVEL HEADING THROUGH FACES
STALL-ROAD
STALL-ROAD
20 DEGREES
STALL-ROAD
JIG



To illustrate the Discussion on "Well-sinking in the Punjab."

FIG. 1.—SECTION OF A WELL ON LINE AB OF FIG. 2.

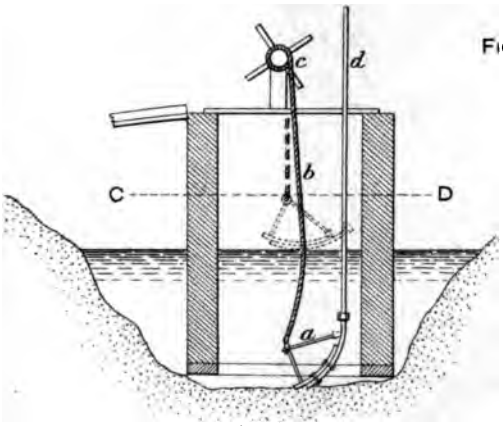
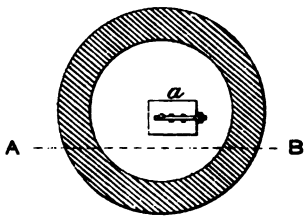


FIG. 2.—PLAN OF A WELL AT THE LEVEL OF LINE CD OF FIG. 1.



Scale, 12 Feet to 1 Inch.

FIG. 3.—ELEVATION OF A PERSIAN WHEEL

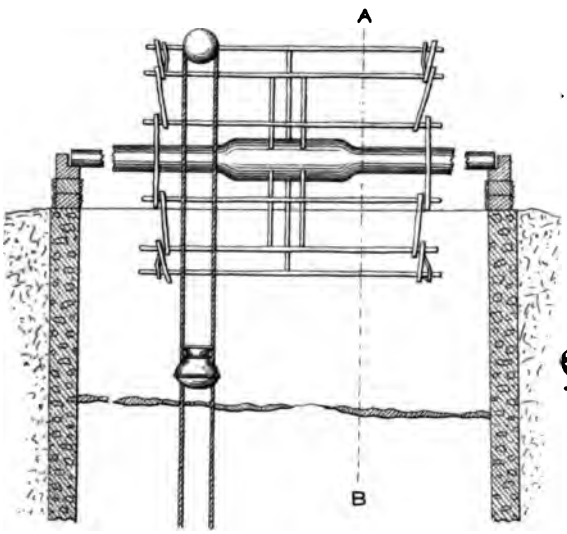
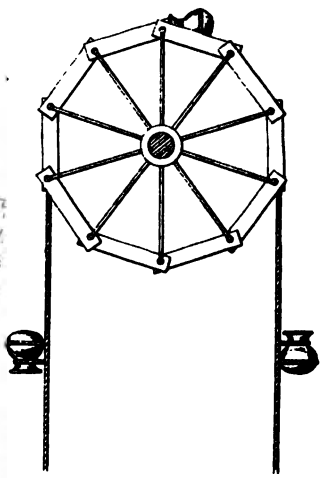
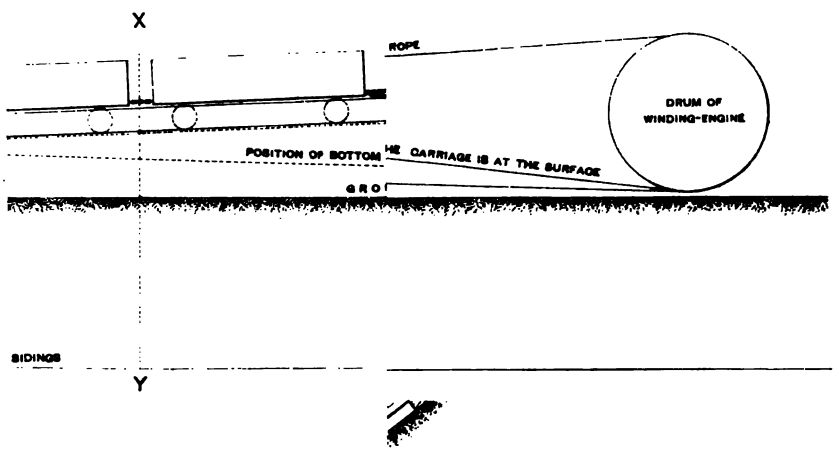


FIG. 4.—SECTION ON LINE AB OF FIG. 3.



Scale, 3 Feet to 1 Inch.

FIG. 3.—ELEVATION OF THI



ELEVATION AT THE BOTTOM OF THE INC

4.—SECTION ON LINE XY OF FIG. 3.

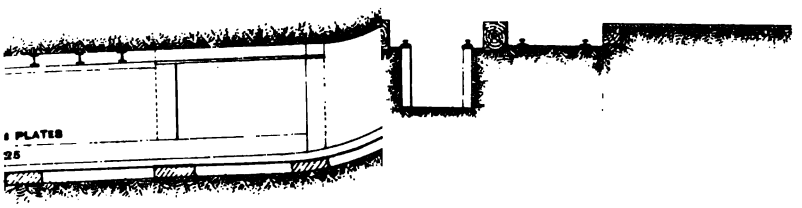
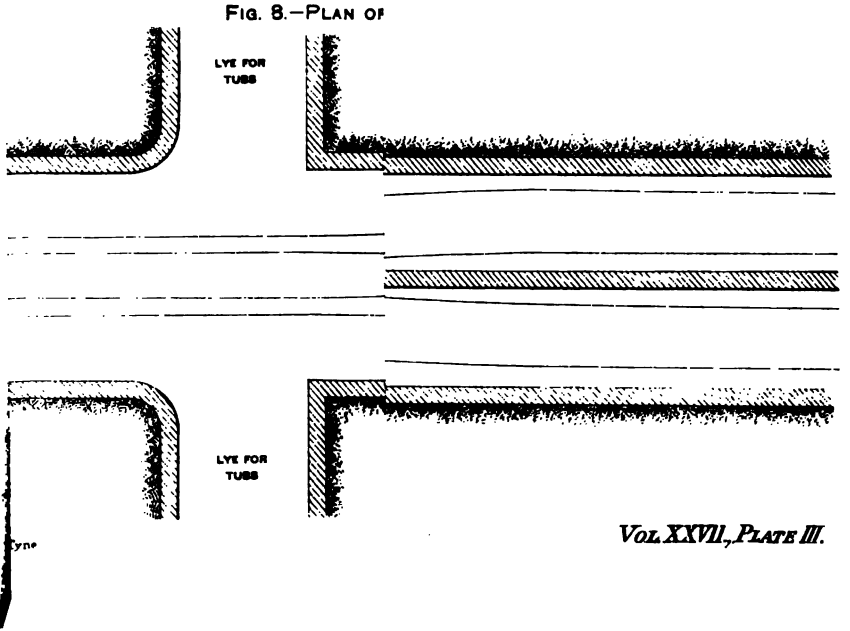


FIG. 8.—PLAN OF



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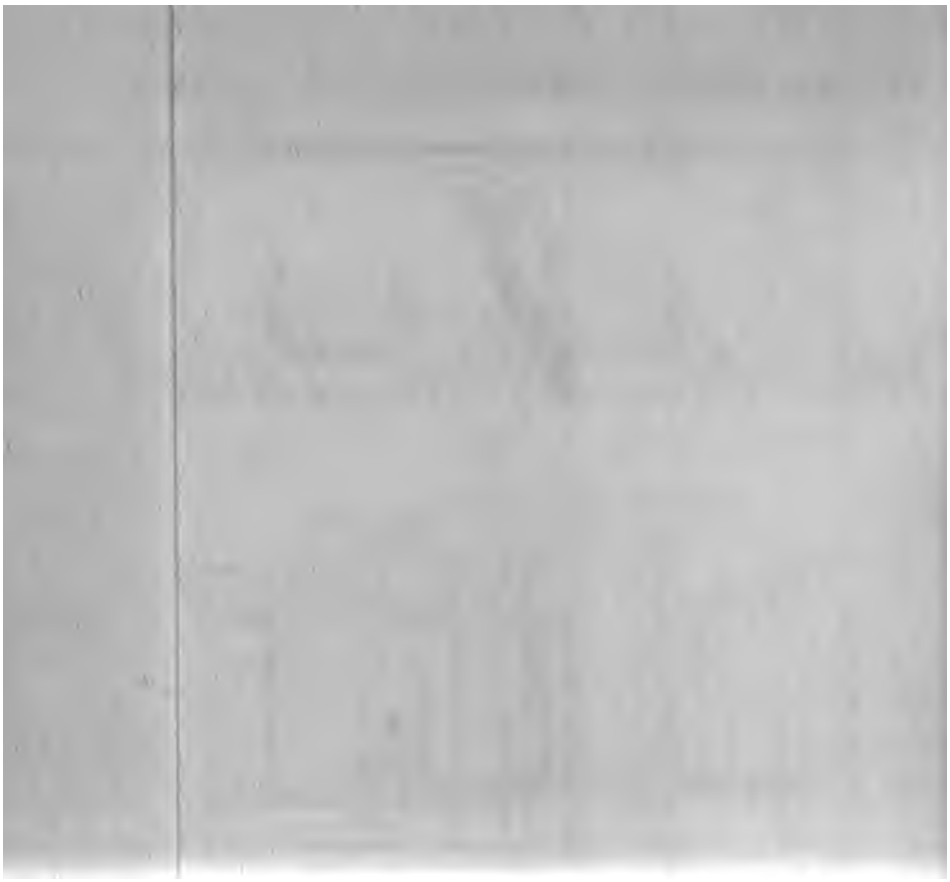
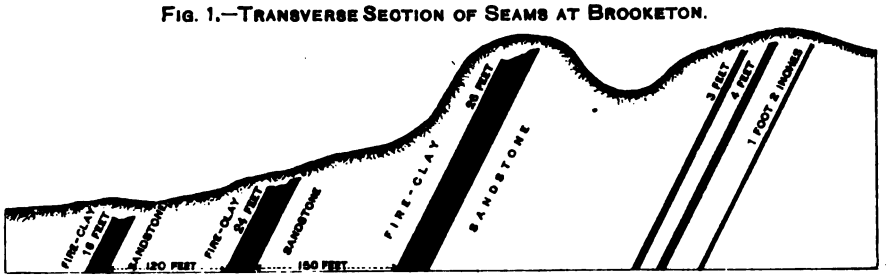


To illustrate Mr. James Roden's Paper on "Coal-mining in Borneo."

FIG. 1.—TRANSVERSE SECTION OF SEAMS AT BROOKETON.



Scale, 200 Feet to 1 Inch.

FIG 2.—TRANSVERSE SECTION OF VERTICAL SHAFT, SHEWING MAIN DOOK AND BOLT-HOLES.

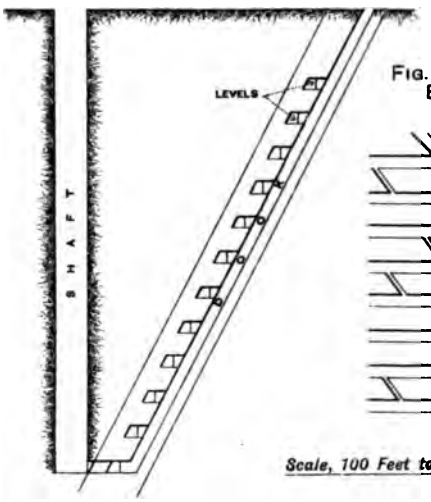
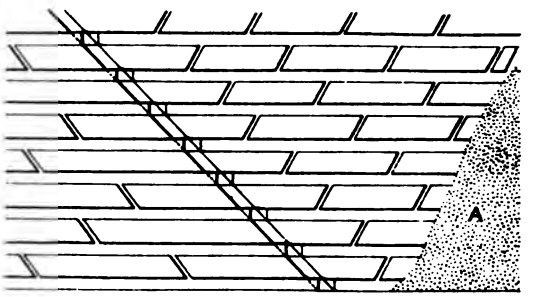
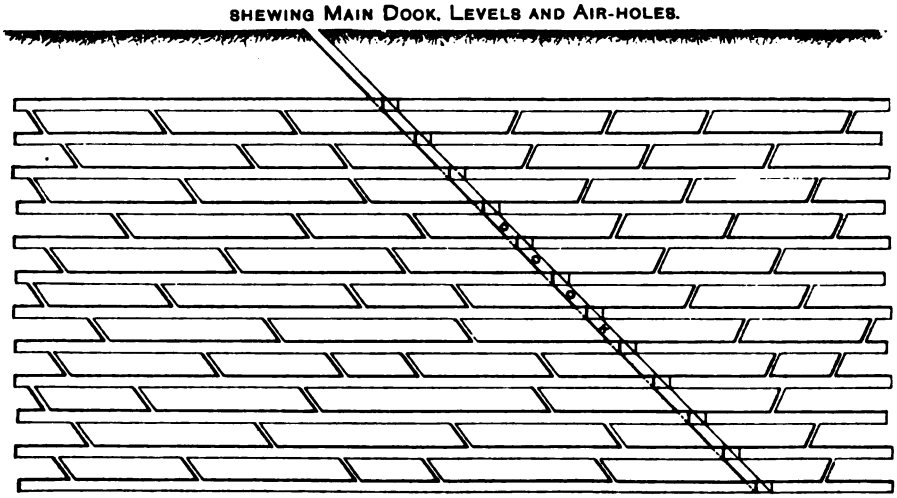


FIG. 4.—LONGITUDINAL SECTION OF WORKINGS AT BROOKETON, SHEWING PROPOSED METHOD OF EXTRACTING STOOPS.



Scale, 100 Feet to 1 Inch.

FIG. 3.—LONGITUDINAL SECTION OF WORKINGS IN 26 FEET COAL-SEAM AT BROOKETON, SHEWING MAIN DOOK, LEVELS AND AIR-HOLES.



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Scale, 100 Feet to 1 Inch.

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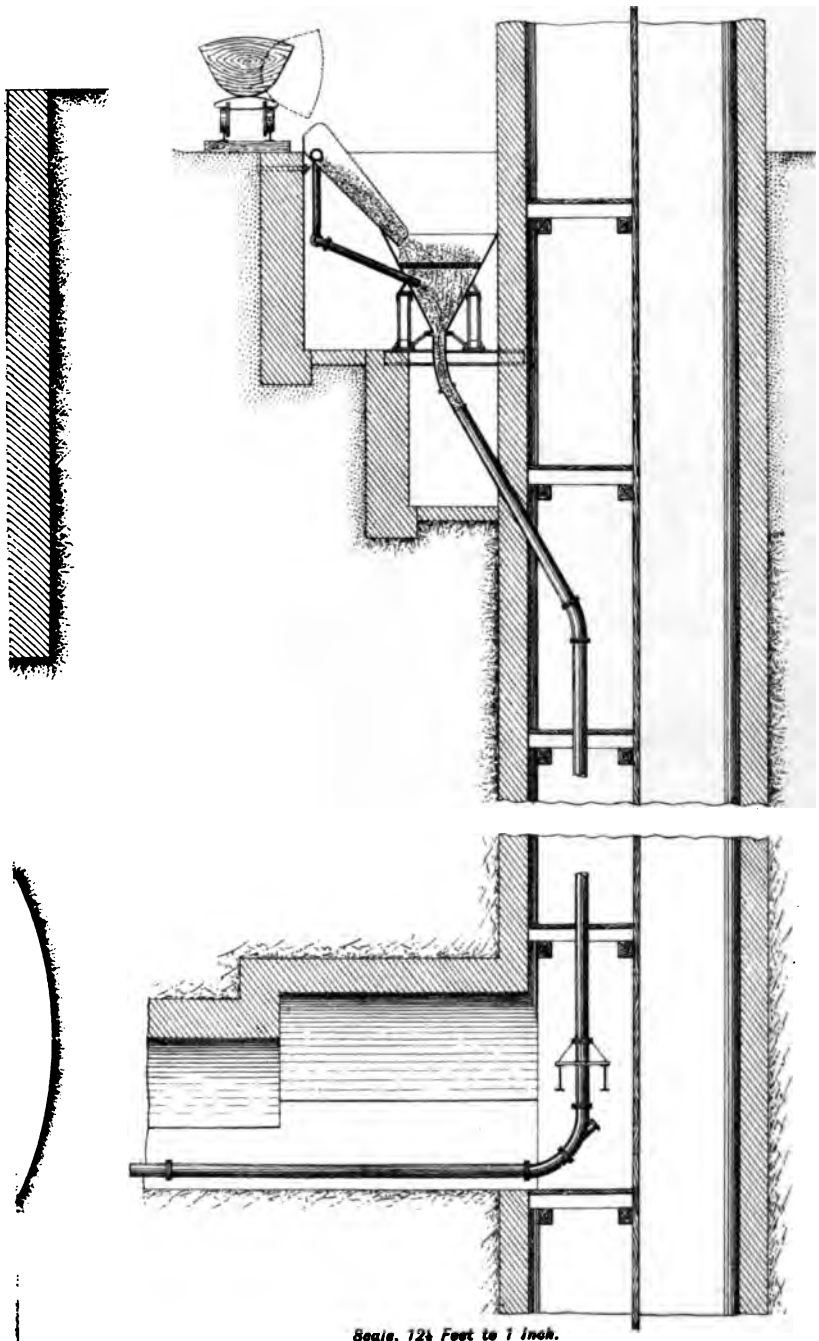
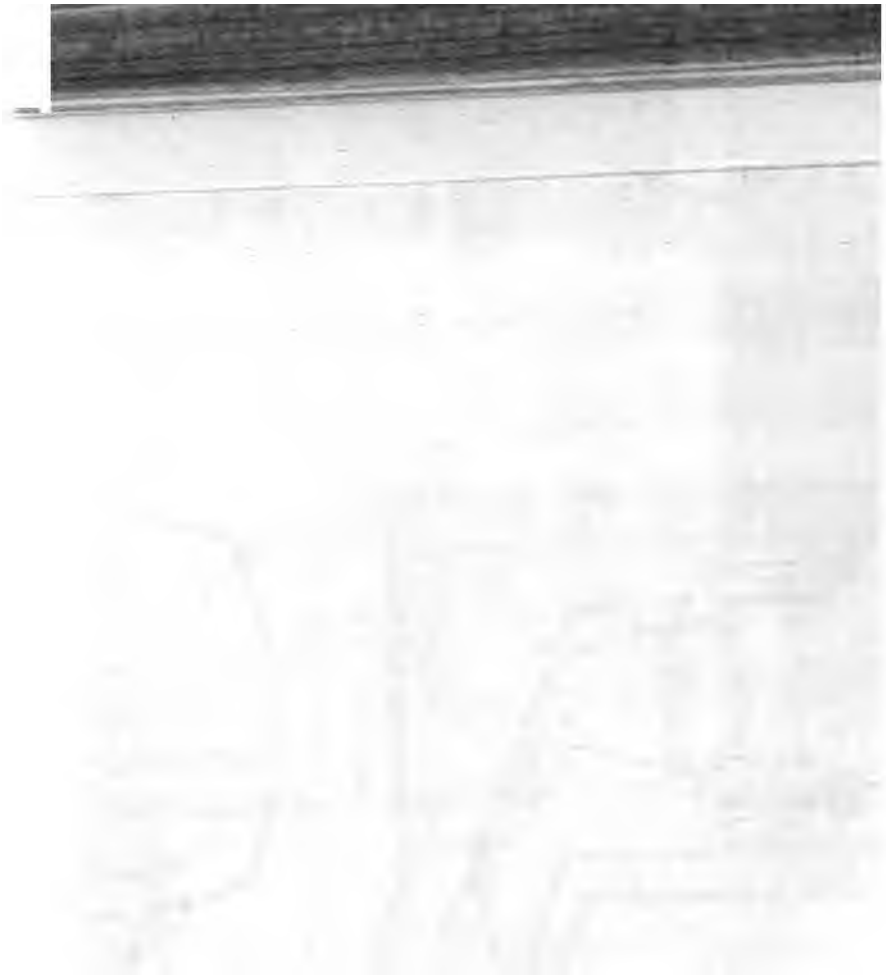
And.ᵂ Reid & Compᵞ Lᵗᵈ Newcastle upon Tyne.

FIG. 8.—SECTIONAL ELEVATION OF FUNNEL SHAFT AT FERDINAND COLLIERY.

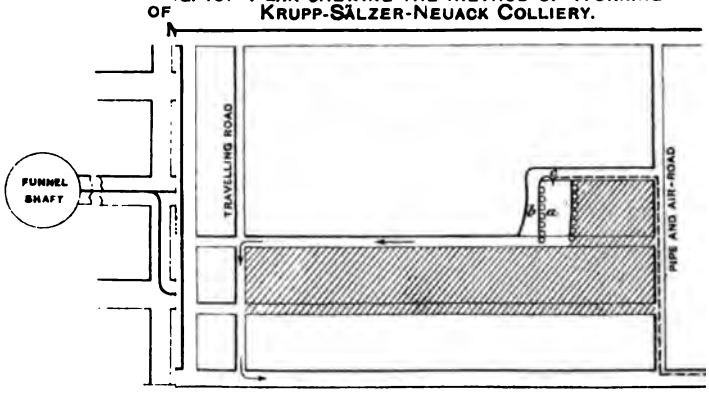


Scale, 12½ Feet to 1 inch.



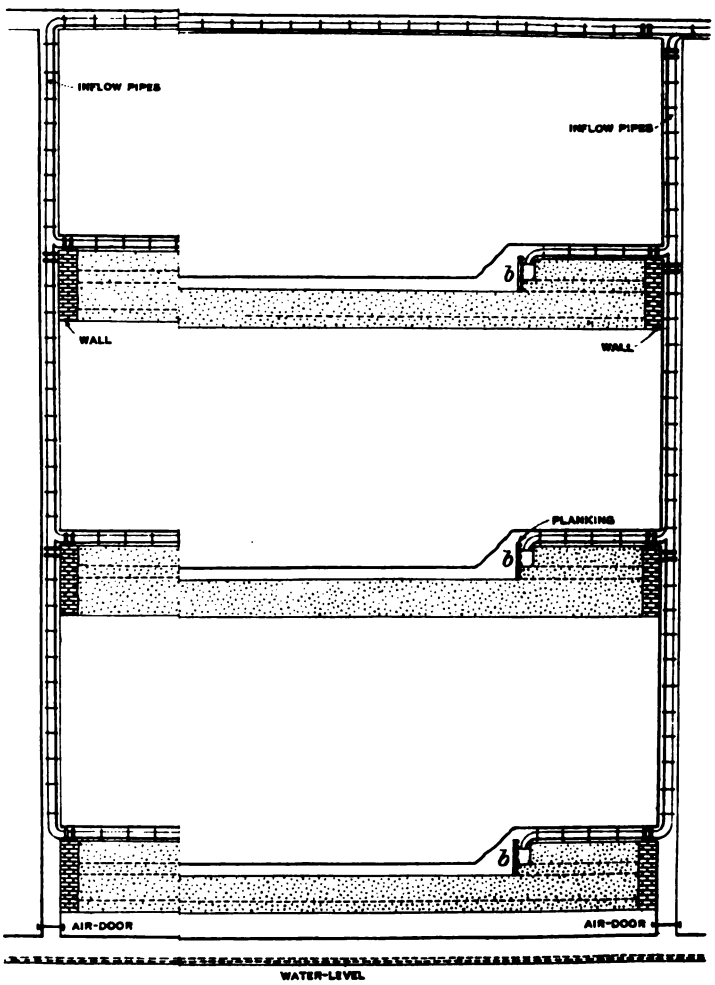
To illustrations in Coal-seams by means of Water."

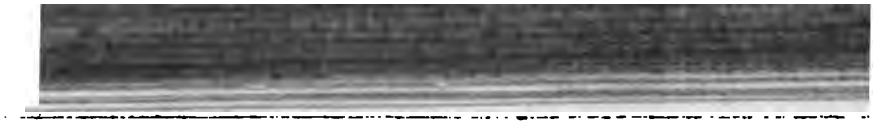
FIG. 9.—FIG. 10.—PLAN SHEWING THE METHOD OF WORKING AT KRUPP-SÄLZER-NEUACK COLLIERY.



Scale, 90 Feet to 1 Inch.

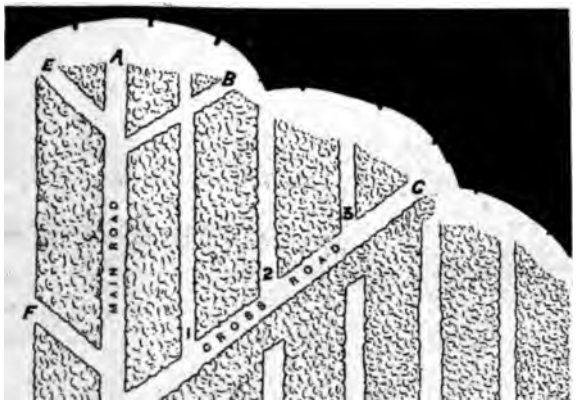
OF WORKING

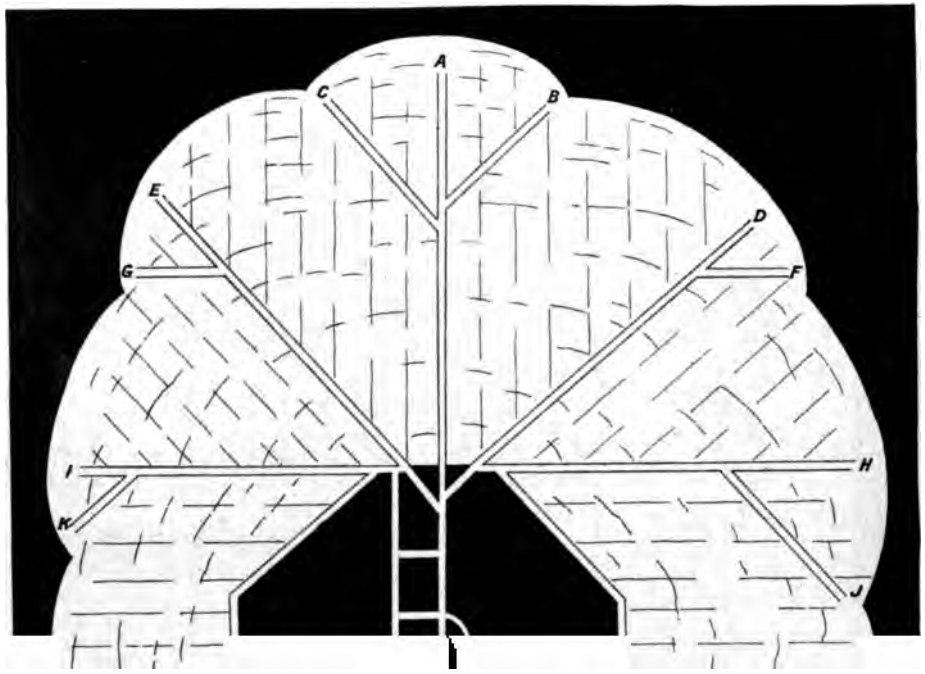


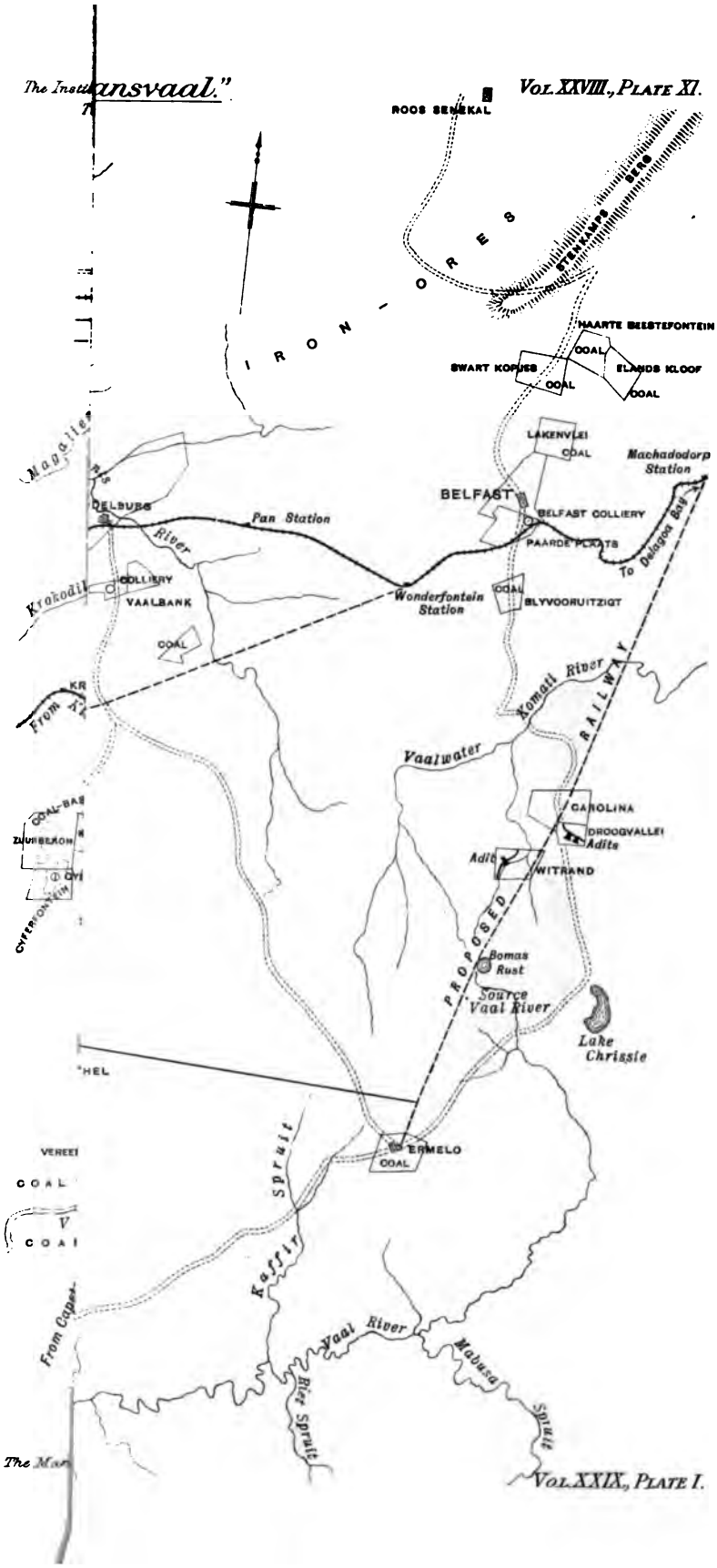


To illustrate Mr. J. T. Beard's Paper on "The Action, Influence and Control of the Roof in Longwall Working."

FIG. 1.—SECTION OF WORKING-FACE.






The Inst ansvaal."
VOL. XXVIII., PLATE XI.
ROOS SENEKAL
I R O N - O R E S
STINKKAMPS BERG
HAARTE BEESTEFONTEIN
COAL
SWART KOPJES
ELANDS KLOOF
LAKENVLEI
COAL
Machadodorp Station
BELFAST
BELFAST COLLIERY
PAARDE PLAATS
To Delagoa Bay
Pan Station
River
DELBURG
COLLIERY
VAALBANK
Krokodil
Wonderfontein Station
BLYVOORUITZIGT
Komati River
RAILWAY
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From Cape
Vaal River
Mabusa
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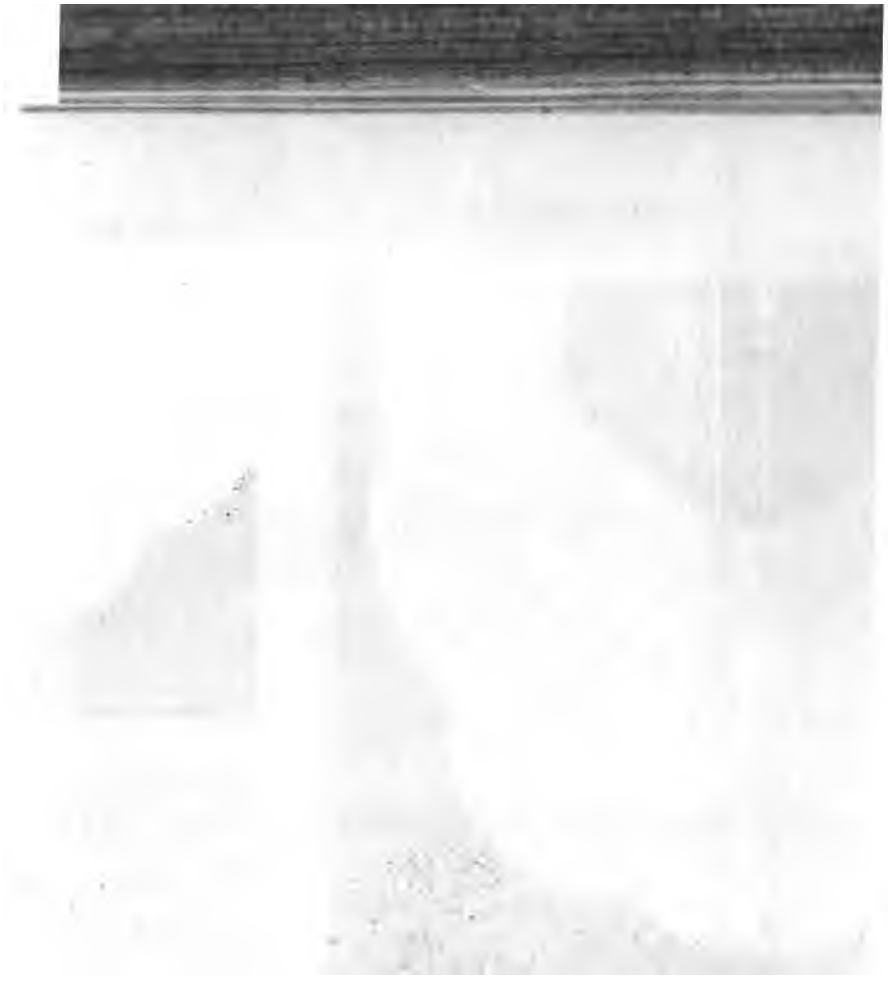
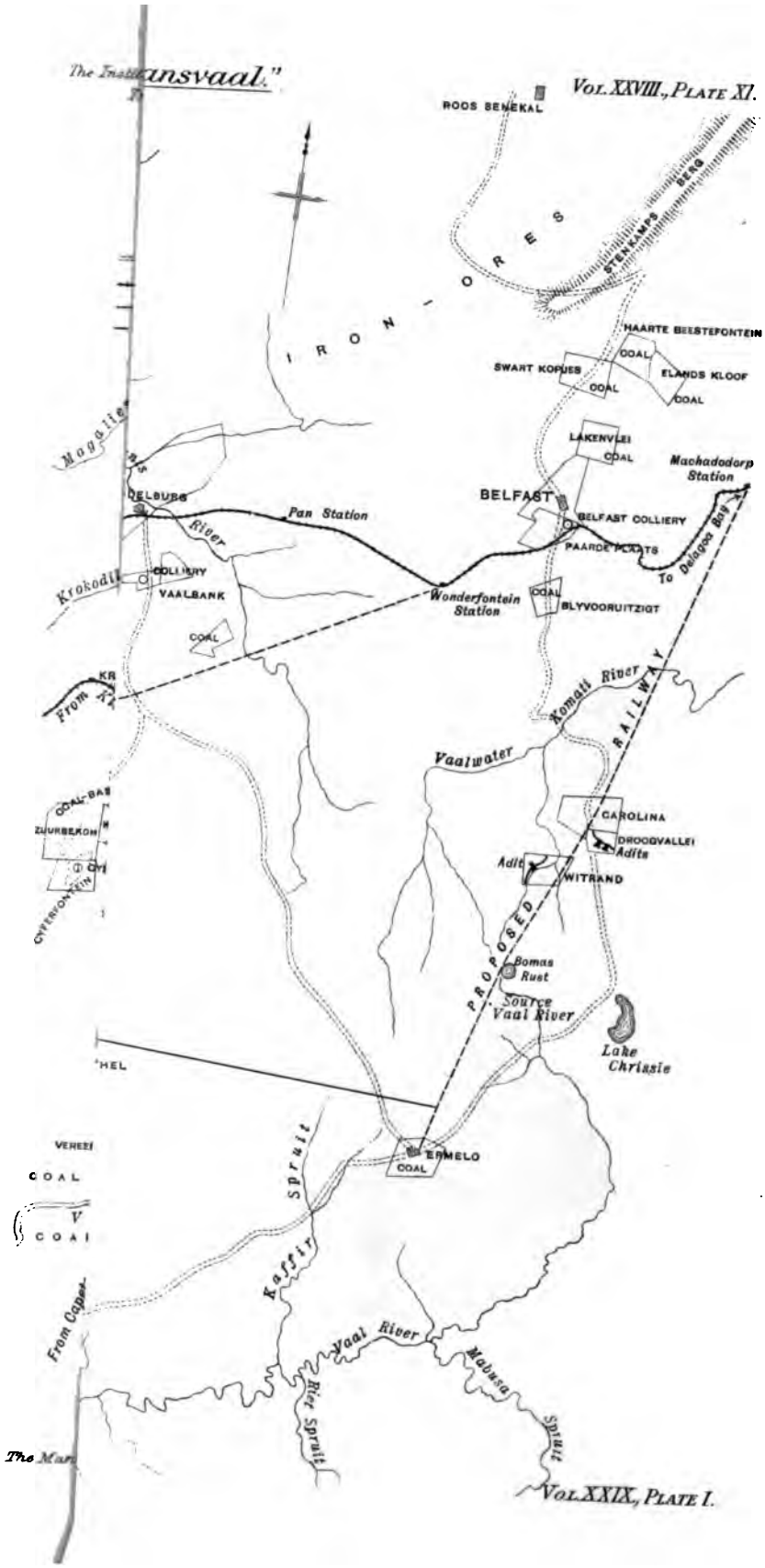
VOL. XXIX., PLATE I.




The Transvaal."
VOL. XXVIII., PLATE XI.
ROOS SENEKAL
IRON ORES
STEENKAMPS BERG
HAARTE BEESTEFONTEIN
COAL
SWART KOPJES
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Madusa
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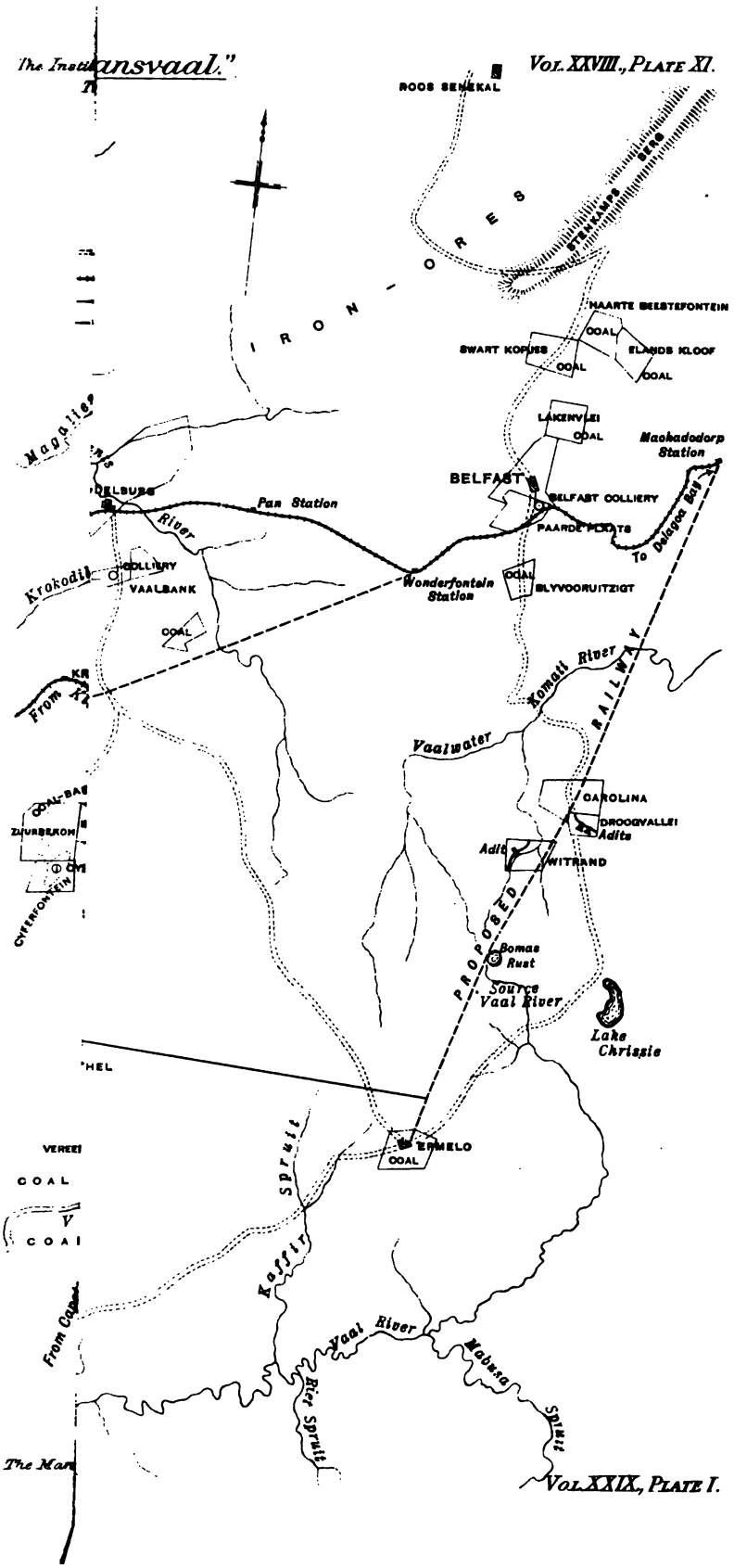
VOL. XXIX., PLATE I.


ROOS SENEKAL
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HAARTE BEESTEFONTEIN
COAL
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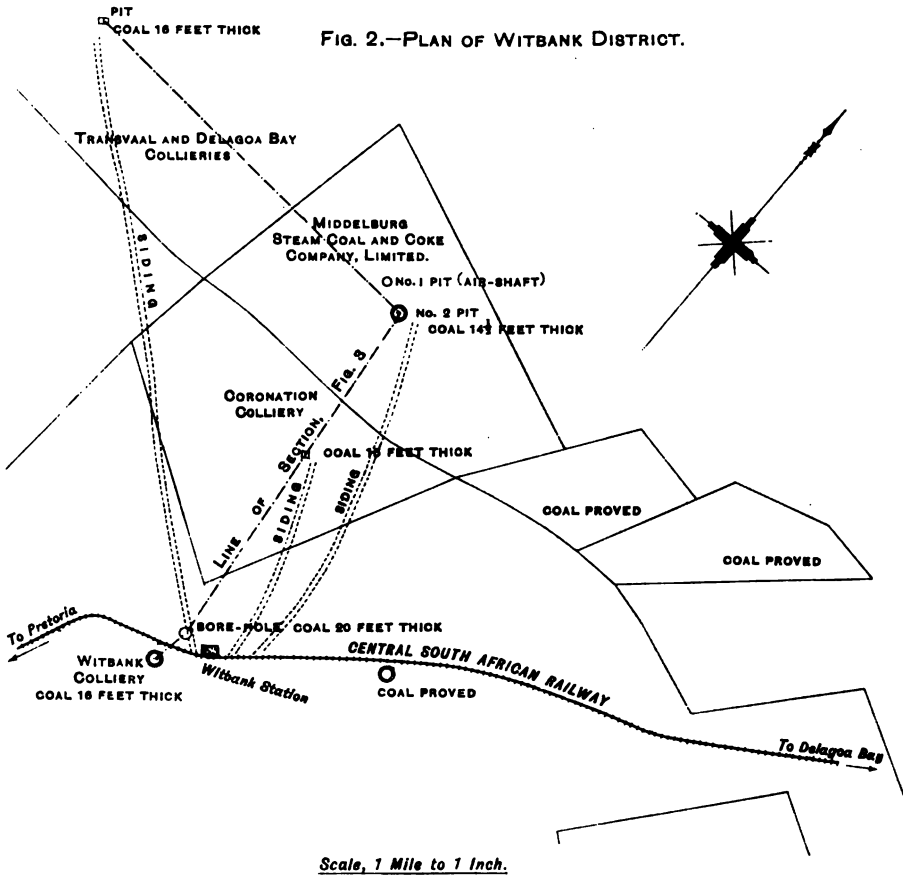
Source Vaal River
Lake Chrissie
ERMELO
VEREE
COAL
Kaffir Spruit
From Copp
Vaal River
Mobasa Spruit
River Spruit
The Mar
Vol. XXIX., Plate I.

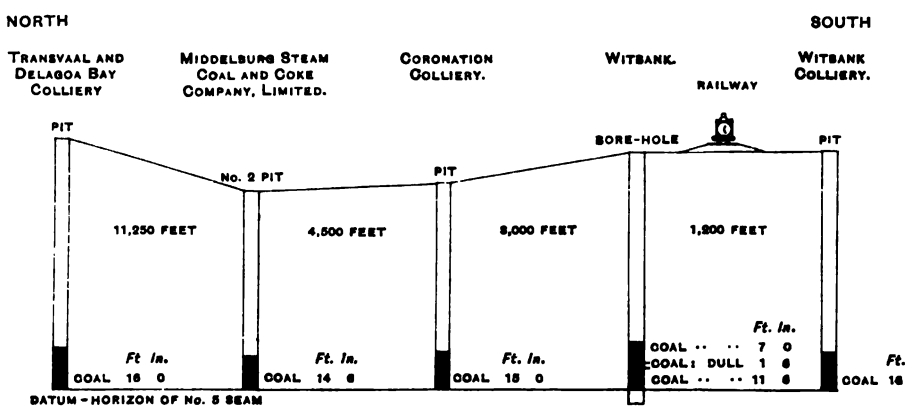
To illustrate Mr. J. J. Whitehead's "Notes on Coal in the Transvaal."

FIG. 2.—PLAN OF WITBANK DISTRICT.



Scale, 1 Mile to 1 Inch.

FIG. 3.—SECTIONS IN WITBANK DISTRICT.



Vertical Scale, 80 Feet to 1 Inch.

To illustrate Prof. H. Louis' Paper on "Coal-mining in Asturias, Spain."

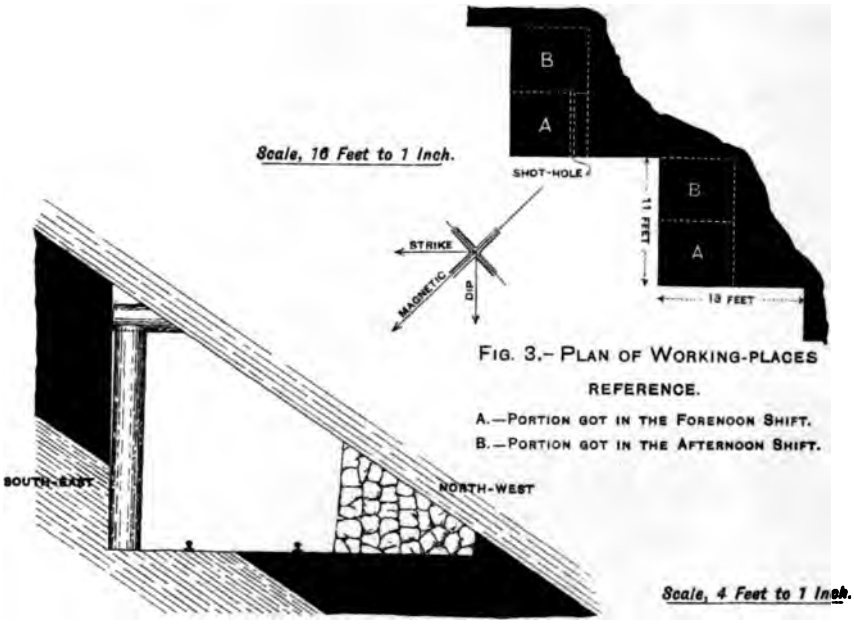


FIG. 3.—PLAN OF WORKING-PLACES REFERENCE.

A.—PORTION GOT IN THE FORENOON SHIFT.

B.—PORTION GOT IN THE AFTERNOON SHIFT.

FIG. 1.—SECTION OF DRIFT.

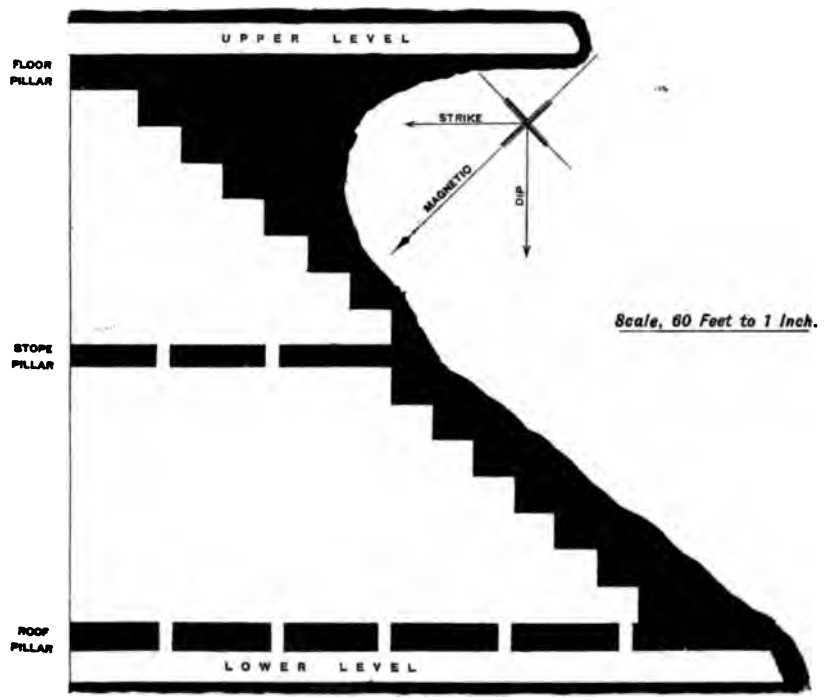
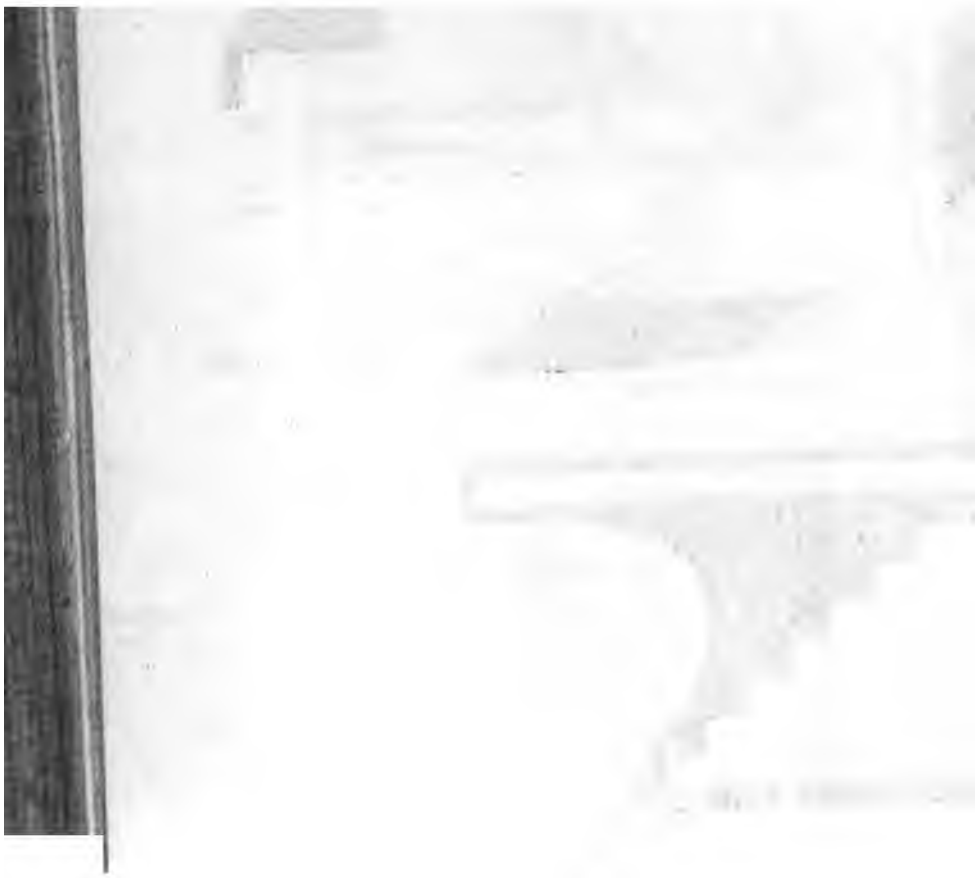


FIG. 2—PLAN.

And.ᵛ Reid & Comp.ʸ L.ᵗᵈ Newcastle upon Tyne.



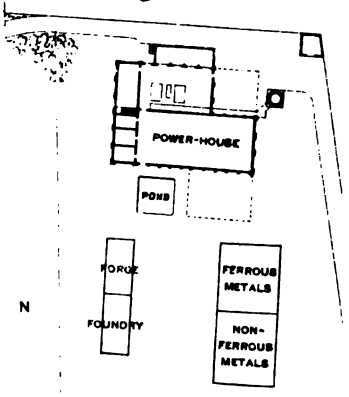
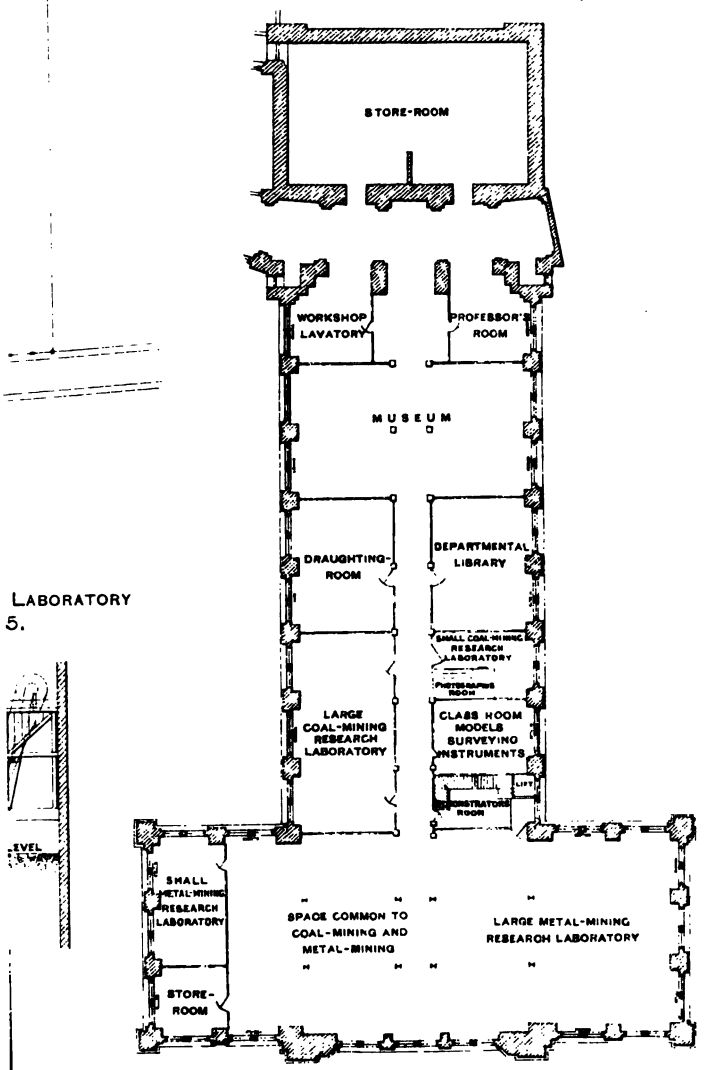


FIG. 4.—PLAN OF THE LOWER GROUND-FLOOR, BLOCK C.



Scale, 40 Feet to 1 Inch.

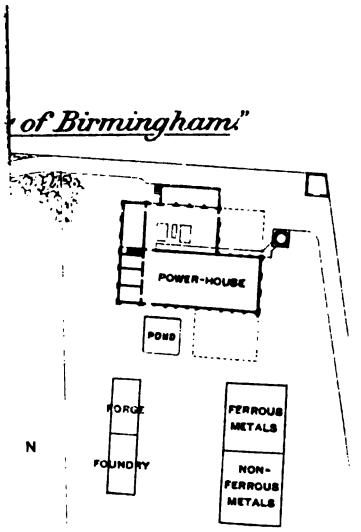
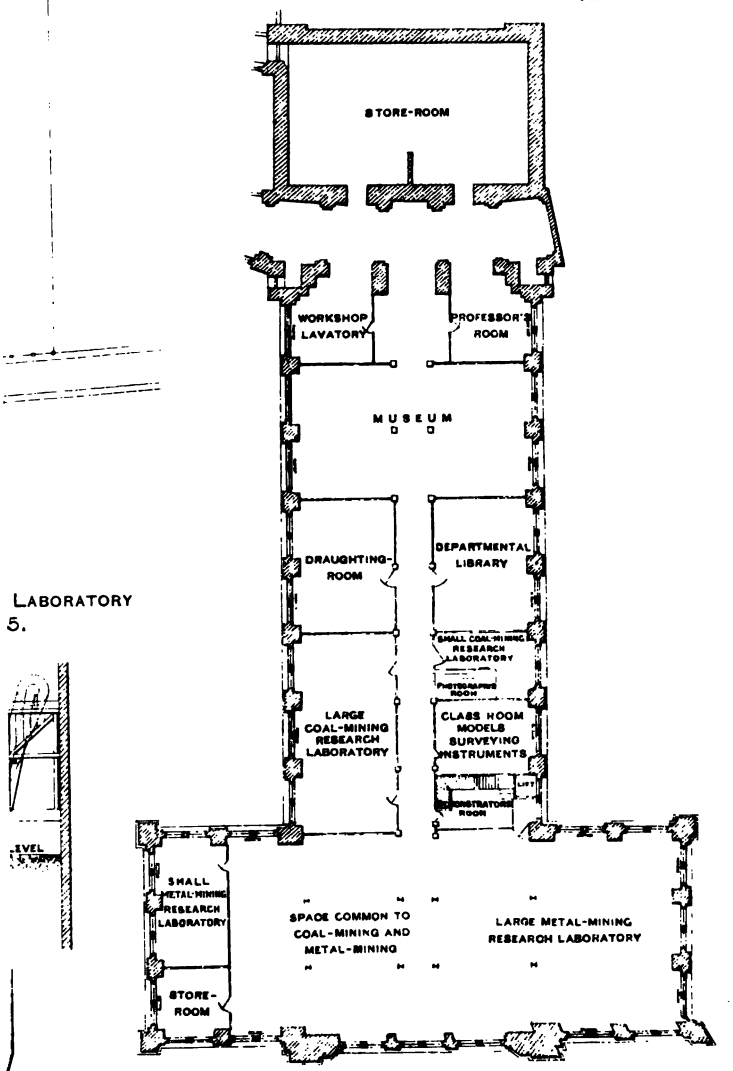


FIG. 4.—PLAN OF THE LOWER GROUND-FLOOR, BLOCK C.



Scale, 40 Feet to 1 Inch.

To illustrate University of Birmingham"

FIG. 7.—SIDE-ELEVATION OF M OF THE EXPERIMENTAL COAL-MINE.
FOR THREE-STAMPS

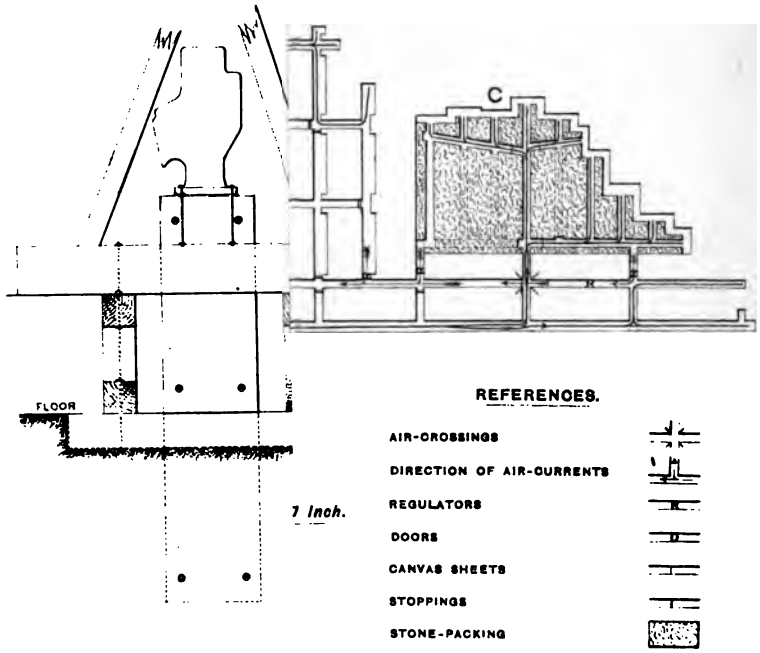
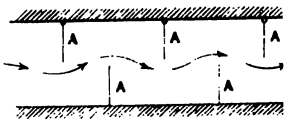


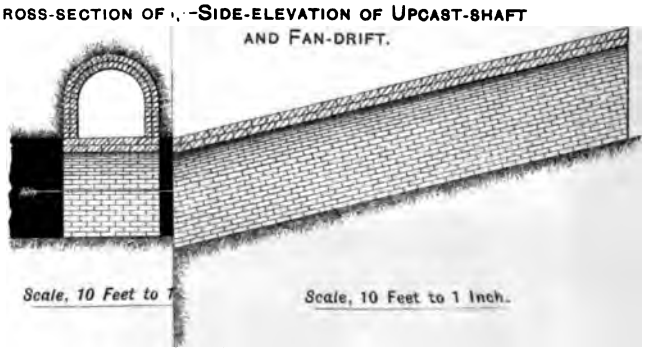
FIG. 10.—PLAN.—CROSS-SECTION OF THE LONGWALL-FACE, C.



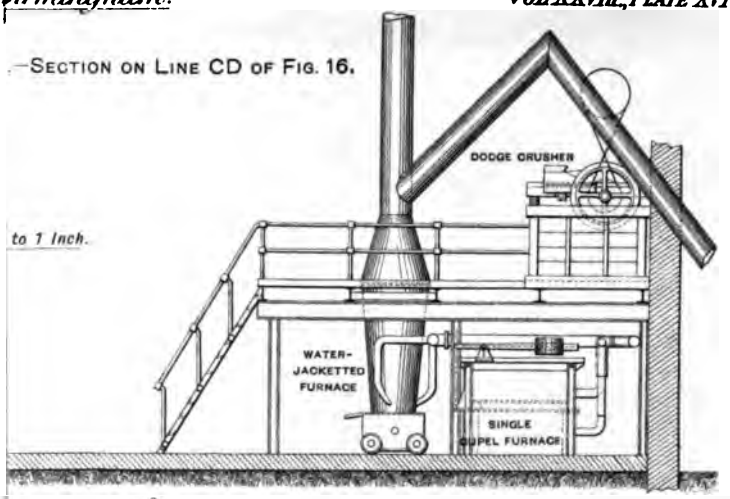
Scale, 10 Feet to

Scale, 10 Feet to 1 Inch.

FIG. 13.— CROSS-SECTION OF , —SIDE-ELEVATION OF UPCAST-SHAFT AND FAN-DRIFT.

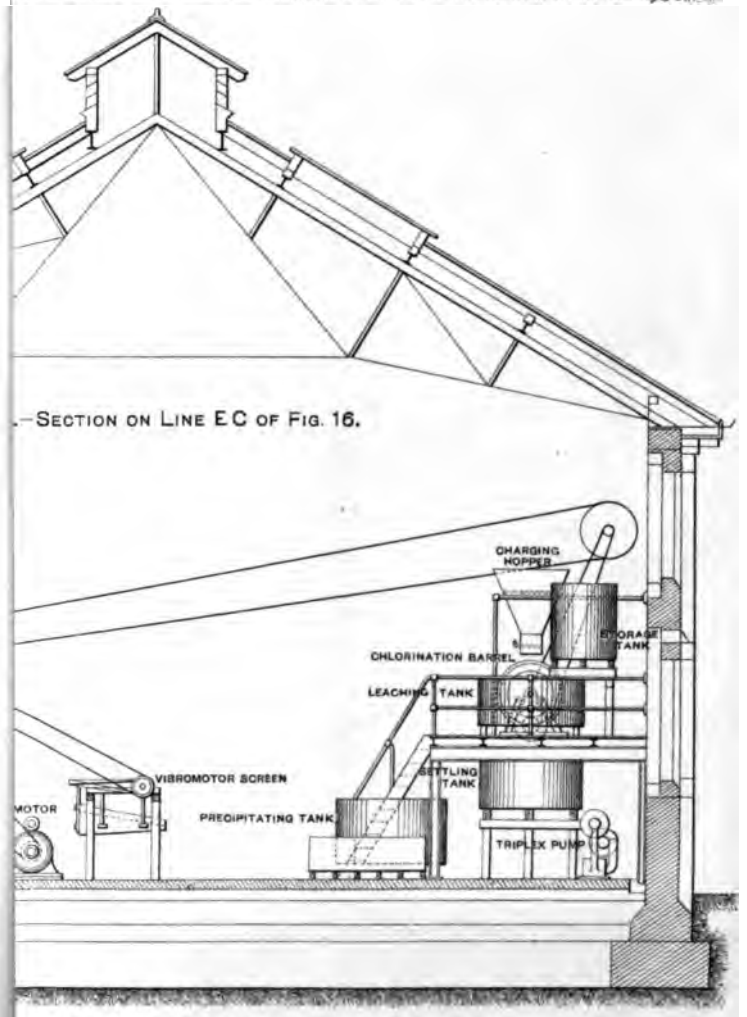


—Section on Line CD of Fig. 16.



to 1 Inch.

—Section on Line EC of Fig. 16.



Scale, 10 Feet to 1 Inch.

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